Message

From: Bolen, Brittany [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=31E872A691114372B5A6A88482A66E48-BOLEN, BRIT]
Sent: 5/23/2017 4:46:57 PM
To: Michael K. Henry [mhenry@alpinegroup.com]
CC: Carolyn Inge (Inge.Carolyn@epa.gov) [Inge.Carolyn@epa.gov]; Kime, Robin [Kime.Robin@epa.gov]
Subject: RE: Meeting Request

Hi Mike,
Thanks for your email. Please work with Carolyn (cc'd) on scheduling a meeting.
Best,
Brittany

Brittany Bolen
Deputy Associate Administrator, Office of Policy
U.S. Environmental Protection Agency
(202) 564-3291
Bolen.Brittany@epa.gov

From: Michael K. Henry [mailto:mhenry@alpinegroup.com]
Sent: Monday, May 22, 2017 2:12 PM
To: Bolen, Brittany <bolen.brittany@epa.gov>
Subject: Meeting Request

Brittany-

Hope all is well with the move to EPA!

Any chance you have time in the next week or so to meet with me and a client, the Rubber Manufacturers Association (RMA)? We would like to come in and discuss issues in your purview relative to the domestic tire manufacturers - including the nanomaterial reporting rule, residual risk and technology review, Phase 2 rule, biomass and TSCA implementation.

Following are some bullets from a letter they transmitted in May, just to give you some color of what's currently on their radar.

Do you have time to meet with us?

Thanks!!

Mike

- RMA encourages EPA to meet the court deadline (2018 or 2020) for completing the RTR review of the Tire MACT

- RMA members are committed to effective implementation of the Frank R. Lautenberg Chemical Safety for the 21st Century Act (LCSA).

- RMA recommends that EPA stay the effective date of the nanomaterial reporting rule until guidance is issued to clarify reporting obligations in the rule.

- RMA encourages EPA to accept RMA's petition for reconsideration of the Phase 2 rule and issue technical corrections to address the issues raised.

- RMA recommends that EPA designate biomass as carbon neutral and remove the burden of ASTM testing to determine the biogenic fraction of tire-derived fuel (TDF).

Appointment

From: Carpenter, Thomas [Carpenter.Thomas@epa.gov]
Sent: 9/24/2018 2:59:07 PM
To: Carpenter, Thomas [Carpenter.Thomas@epa.gov]; William Schlesinger [schlesingerw@caryinstitute.org]; jeanne@cmu.edu; Michael Honeycutt (Michael.honeycutt@tceq.texas.gov) [Michael.honeycutt@tceq.texas.gov]; Brennan, Thomas [Brennan.Thomas@epa.gov]; Steven Hamburg [shamburg@edf.org]

Subject: Public commenters and QR comment review
Attachments: EPA_Biogenic CO2 Emissions_LeadReview.docx; Draft Comment on SAB report 9 24 2018.pdf; West public comment biogenic.pdf
Location: Telephone 1 866 299 3188 Ex. 6 - Personal Privacy

Start: 9/24/2018 3:00:00 PM
End: 9/24/2018 3:30:00 PM
Show Time As: Tentative

I will ask for comments by 9/19 and distribute Friday or over the weekend and add to this invite
I sent the combined comments Thursday evening. Two additional comments came in over the weekend and Surabi's Madhu Khanna et al and Tristam West – They are attached

9/24/2018

Mr. Thomas Carpenter
Designated Federal Officer (DFO)
EPA Science Advisory Board (1400R)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW.
Washington, DC 20460

From: Madhu Khanna, Robert Abt, Dan Schrag, Ken Skog[1]

Sent via email to carpenter.thomas@epa.gov

RE: **Science Advisory Board (SAB) 8-29-18 Draft Report for Quality Review**

We are members of the Biogenic Carbon Emissions Accounting Panel of the Science Advisory Board (SAB) that were appointed to review EPA's proposed *Frameworks for Assessing Biogenic CO_2 Emissions from Stationary Sources* in 2011 and 2014. The Panel wrote and unanimously approved a Panel Advisory Report that reviewed the 2014 Framework. The Chartered SAB did not approve the Panel's report and has developed its own version—the SAB Draft Report for Quality Review that we are discussing today. The SAB Draft Report introduces modifications to the Panel's Advisory Report by inserting text and excluding sections and figures without clearly demarcating their changes and attributing the portions carried over from the Panel's report. Most importantly, the SAB has modified key recommendations of the Panel. **The current SAB draft report is from the SAB, not the Panel, and it does NOT represent the views of the 18 biogenic emissions experts on the Panel. As a result, we, members of the Panel, do not agree with the recommendations and do not approve of the current draft report.** Below, we discuss our specific concerns.

I. CONCERNS WITH THE PROCESS

The SAB convened and reconvened a panel of scientists to evaluate EPA's proposed biogenic carbon emissions accounting framework. The Biogenic Carbon Emissions Accounting Panel (referred to as the "Panel" throughout this document) was created because the SAB did not have the required scientific expertise to review the framework proposed by EPA on this topic.[2] The resulting Panel included scientific experts in agronomy, silviculture, forestry, soil science, greenhouse gas (GHG) inventories and carbon accounting, engineering, economics, climate science, carbon cycle science, and policy design. See Table 1 for the list of panelists.

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[1] The following Panel members provided helpful comments and suggestions in the drafting of this memorandum: Steven Rose, Jason Hill and Tristam West. However, the Panel members formally transmitting this memorandum are responsible for its content and communication.

[2] EPA SAB Office letter October 3, 2011 forming the SAB Biogenic Carbon Emissions Panel, https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235dac747c16fe985257da90053f252!OpenDocument&TableRow=2.1#2.

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Table 1. Biogenic Carbon Emissions Panel Convened by the SAB

CHAIR – Dr. Madhu Khanna, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign

PANEL MEMBERS

Dr. Robert Abt, Department of Forestry and Environmental Resources, North Carolina State University
Dr. Morton Barlaz, Civil, Construction, and Environmental Engineering, North Carolina State University
Dr. Marilyn Buford, Silviculture Research, USDA Forest Service
Dr. Richard Birdsey*, Climate, Fire, and Carbon Cycle Sciences, USDA Forest Service
Dr. Mark Harmon, College of Forestry, Oregon State University
Dr. Jason Hill, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota
Dr. Stephen Kelley*, College of Natural Resources, North Carolina State University
Dr. Richard Nelson*, Kansas State University Center for Sustainable Energy
Dr. Lydia Olander*, Nicholas Institute for Environmental Policy Solutions, Duke University
Dr. John Reilly, Center for Environmental Policy Research, Massachusetts Institute of Technology
Dr. Charles Rice, Department of Agronomy, Soil Microbiology, Kansas State University
Dr. Steven Rose, Energy and Environmental Analysis, Electric Power Research Institute
Dr. Daniel Schrag, Earth and Planetary Sciences, Harvard University
Dr. Roger Sedjo, Center for Forest Economics and Policy Program, Resources for the Future
Dr. Ken Skog, Forest Products Laboratory, USDA Forest Service
Dr. Tristram West, Joint Global Change Research Institute, University of Maryland
Dr. Peter Woodbury, Department of Crop and Soil Sciences, Cornell University
* 1st Advisory panelist only

The Panel was formed in October 2011 and provided its first Advisory Report to EPA in September 2012. The Panel was then reconvened in November 2014 and provided its second Advisory Report to the SAB in March 2016 and a revised version in August 2017. Over the seven years, the Panel engaged in extensive deliberations and met over 30 times (in-person and virtually, in sub-groups and as a whole). ***The Panel provided expert consensus advice to EPA through*** two advisory reports (in 2012 and 2017) that represented the combined and unified science-based guidance from 18 scientific experts.

Unfortunately, a few SAB members disagreed with the Panel's 2017 Advisory Report to EPA and argued for changes. The Panel had made numerous revisions requested by the SAB but was not able to satisfy these few SAB members. In August 2017, the EPA disbanded the Panel and the SAB took over the process and has now developed its own advisory report to EPA. **To be absolutely clear, the current draft advisory is from the SAB, not the Panel, and it does NOT represent the views of the 18 biogenic emissions experts on the Panel.**

The SAB developed their draft advisory report by selectively deleting and replacing key sections of the Panel's guidance, which meaningfully deviate from the Panel's expert and science-based guidance. The SAB changes are not clearly delineated or discussed. In particular, the rationale for SAB changes is not explained or justified scientifically.

The SAB's disbanding of the Panel and setting aside of the Panel's guidance to EPA has significant implications that undermine the overall role of scientific peer review in informing EPA:

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1. It overrides and ignores the consensus opinion of 18 scientific experts on this topic.
2. It implies either that the scientific expertise represented on the Panel is not needed to effectively advise EPA on this topic or that the SAB believes it has greater expertise on biogenic emissions than the Panel for advising EPA on this topic.
3. It undermines transparency and scientific integrity by not clearly delineating edits to the Panel's report clearly and providing a rationale for differences from the Panel's guidance.
4. It confuses the public by providing a report that is internally inconsistent and inconsistent with the findings of 18 experts on the topic. For example, the figures in the 08/29/18 Draft are based on the definition of time horizon in the Panel's report while the time horizon is now being redefined as being based on a policy horizon. **The figures in the report no longer support the text that has been overlaid on the Panel's report and this makes the current advisory technically inconsistent.**
5. And, it has broader ramifications for the integrity of science and the objectivity of the SAB for advising the agency.

What would have been more appropriate for greater transparency and scientific integrity?

- Separate SAB opinion –The SAB should have expressed its views as a separate document from the Panel's advice. The document should have explained and defended its advice and positions relative to the Panel's. Separate SAB guidance and clearly presented SAB scientific arguments would have been constructive and informative for EPA and the public, facilitating more informed discussion and decisions. The SAB's current approach of selectively editing the Panel's document without appropriate attribution lacks transparency, introduces inconsistencies and misleads the public by not fully representing their counter-opinions and its justifications separately.

- Panel review of SAB opinion – The SAB should have asked the Panel to review and respond to the SAB's advice once documented. It is scientifically troubling that the SAB chose not to return to the Panel of experts for feedback on its proposed advice to EPA, and they even went so far as to disband the Panel. While Panel members can provide individual public comments today, this is very different from asking the Panel to discuss and respond as a group of experts to the SAB advice.

A better process is needed in the future

The SAB office needs to revise its process for Panel guidance. It is flawed. If the SAB decides it is appropriate to convene a panel of experts to provide guidance to EPA (because the SAB lacks the necessary set of expertise), then this deference to a panel for scientific guidance should be extended to the advice provided by the panel. A consensus opinion from a panel of relevant experts is extremely difficult to obtain and is a significant scientific statement of great value to the public and EPA. That should not be undermined by a few SAB members who might have a different opinion. The SAB's role in a quality review of the panel advice should be to assure that the panel has addressed charge questions and supported its advice in a technically sound manner as well as clearly communicated it. The quality review should not be a way for an SAB member to "join" the panel, and even more problematic have the power to set aside the panel's consensus because a few SAB members do not like it.

II. CHOICE OF TIME HORIZON FOR CALCULATING BAF

It is essential that BAF calculations be based on science and not be a function of the policy goals of the administration in office or specific policies. BAFs should be grounded in science and not be a policy lever. BAFs should simply inform policy evaluation and policy stringency decisions and not be based on a policy horizon.

A key modification to the Panel's Report made by the SAB in its 08/29/18 Draft Report is to change the recommendation for setting the time horizon for carbon accounting calculations. The SAB Draft recommends that the BAF calculation time horizon be the policy's time horizon. The Panel's recommendation, on the other hand, is that the BAF calculation time horizon should be policy independent and based on science to account for the expected effects on terrestrial carbon stocks (negative and positive) of using a biogenic feedstock.

The 08/29/18 SAB Draft Report promotes a scientifically-flawed choice of time horizon for calculating a BAF for reasons explained below.

1. **1. A policy horizon is not science-based as demonstrated by the variation in policy horizons across several recent federal policies**. For example, the American Clean Energy and Security Act had a 2050 horizon, while the Clean Power Plan had a 2030 time horizon. And, the Clean Energy Standard Act of 2012 had a 2035 horizon, while the U.S. Nationally Determined Contribution (NDC) GHG target was for 2025.

2. If a BAF is used for several policies that are implemented concurrently and these policies differ in their horizons, then a feedstock will have different BAFs depending on the policy under which it is regulated. Instead of a unique BAF for a feedstock that accounts for all its carbon impacts, the carbon impact of the feedstock will now depend on the policy under which it is being regulated. **Regulated entities will now be able to opportunistically choose which policy applies to which feedstock leading to problems of leakage.**

3. The Panel's Report showed that the harvesting of a long rotation feedstock for bioenergy could lead to positive and negative impacts over a period of time in the future after the harvesting occurred. **Use of a policy horizon that is shorter than the time horizon over which a steady state is achieved implies that any (positive or negative) carbon impacts that occur after that policy horizon are not relevant even though we know from climate science that they will have an impact on climate (e.g., Allen et al., 2009; Matthews et al., 2009)**.

4. **There is no scientific argument cited in the SAB Draft Report to justify the view that selecting the time horizon for calculating a BAF to fit a policy horizon will ensure that policy targets within the policy horizon will be met.** As noted in the Panel's report "Policy concerns about climate change should be addressed through the selection of appropriate policies and policy targets for greenhouse gas reduction. The stringency of greenhouse gas reduction policy targets should not affect the methods and time-scale used

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to calculate BAFs." This statement is inconsistent with scientific understanding of how the climate system functions. GHG policies are not designed to change today's climate, or even that of the next few decades. It is well known that climate change is a longer run problem and GHG policies today will affect climate for decades and centuries well beyond the policy's time horizon. Thus, policies with climate goals need to be concerned about potential GHG implications both within and beyond the policy's time horizon.

5. Use of a policy horizon makes the BAF subject to political manipulation based on the interests of stakeholders that are affected by the choice of BAF.

6. **The 08/29/18 SAB Draft promotes a policy-based time horizon, but this is inconsistent with science-based time horizons used in other climate change metrics.** The SAB Draft contends that "Policies designed to affect change in emissions or impacts in the short term will need to be evaluated over the short term, and thus, the relevant time-period for the BAF computation will be that same short term." Letter pg 2, lines14-16. As noted above, this is inconsistent with climate science. It is also inconsistent with the calculation of other climate-related metrics. The following are examples of other scientific metrics that inform policy. In each case the calculation time horizon is determined by science alone, not the policy application or goal. It would be inappropriate to adjust the time horizons for these calculations in the manner proposed by the SAB for BAF calculations.

   a. Social cost of carbon (SCC) metric: The social cost of carbon is an estimate of future economic damages to society from emitting a metric ton of carbon dioxide (CO_2). The estimates are used in regulatory analyses to value the expected benefits of CO_2 reductions associated with policies. The U.S. Government first developed estimates in 2010 and new estimates have been proposed recently by the current administration. The U.S. Government estimates are based on global modeling of potential climate damage effects of a unit of CO_2 for 300 years (to 2300). The multi-century calculation time horizon is designed to capture the very long atmospheric lifetime of CO_2 molecules and the even longer run inertia affects they can create for the global carbon cycle, the climate system, and sea levels. The same SCC estimates are used across agencies (EPA, DOE, DOT, etc.) and policies that vary substantially in terms of goals and time horizons. Computing the SCC with a decade or multi-decade time horizon, as the SAB Draft recommends, would be inappropriate, ignoring the effects of CO_2 that are expected well beyond any policy horizon.

   b. CO_2-equivalent metrics: Currently, the EPA routinely uses a science-based metric of 100-year radiative forcing to characterize the impact of greenhouse gases and determine equivalence among non-CO_2 emissions, such as methane (CH_4) and nitrous ozide (N_2O). The emissions of non-CO_2 greenhouse gases are routinely reported in CO_2 equivalents where 1 tonne CO_2 equivalent is the radiative forcing caused by 1 tonne of CO_2 over 100 years. (USEPA 2018, pg ES-3). The metrics are based on climate science estimates of the radiative forcing effects of each non-CO_2 GHG over

100 years. This CO_2-eq metric is widely used in analysis of the impact of greenhouse gases and policies for addressing climate change. Using a 100-year period for comparing global warming potential for all greenhouse gases instead of a shorter policy horizon is the standard international convention adopted by EPA and the Intergovernmental Panel on Climate Change (IPCC). Using a policy-based horizon for BAFs would be a significant departure from the national and international convention for comparing different greenhouse gases.

III. CHOICE OF BASELINE FOR ASSESSING THE BAF: REFERENCE POINT VS ANTICIPATED BASELINE

The 08/29/18 SAB Draft Report misconstrues the choice of baseline, as we explain below.

The Panel had strongly emphasized that determining additionality and attribution are essential components of science-based biogenic carbon accounting framework. As we had noted in our letter to the Administrator in our Advisory Report in 2012: "Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach."

We had also noted in the Executive Summary of the 2012 Report that "The choice of a fixed reference point may be the simplest to execute, but it does not properly address the additionality question, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of bioenergy. The agency's use of a fixed reference point baseline implies that forest biomass emissions could be granted an exemption simply because of the location of a stationary facility is in an area where forest stocks are increasing".

The 08/29/18 SAB Draft Report recommends using an adjusted reference point approach without providing any scientific justification to support its claim below: "*The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.*"

Figure 1 illustrates why an Updated Reference Point Baseline Approach will provide an incorrect measure of the additional emissions due to the use of bioenergy.

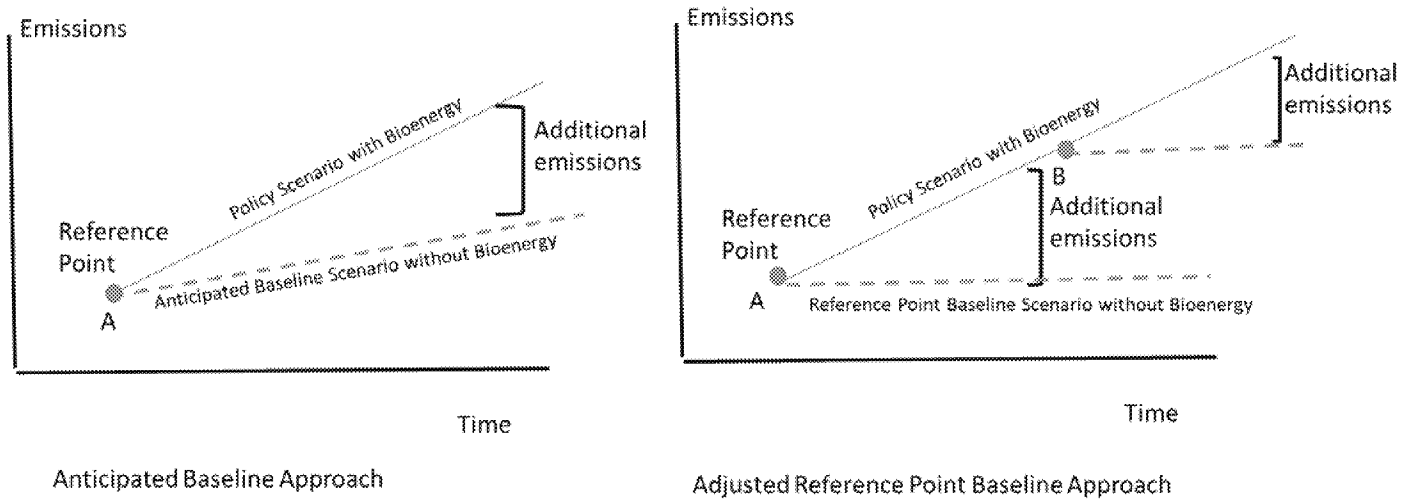

Figure 1: Comparing the Anticipated Baseline Approach with the Adjusted Reference Point Baseline Approach

The graph on the left shows that the anticipated baseline approach measures additional emissions as the difference between the policy scenario with bioenergy and the reference scenario without bioenergy at any point in time. The Reference Point Approach measures additional emissions as the difference between the Policy Scenario and the reference point 'A'. In this illustration, keeping the reference point fixed at 'A' would overestimate the additional emissions as compared to the Anticipated Baseline Approach.

The graph on the right shows that adjusting the reference point from 'A' to 'B' does not correct the basic flaw of the reference point approach. Additional emissions estimated relative to the updated reference point 'B' would now be an underestimate compared to estimates that would be obtained using the anticipated baseline.

IV. USING A SIMPLER MODEL INSTEAD OF A COMPLEX INTEGRATED MODEL TO ESTIMATE THE ANTICIPATED BASELINE

The 08/29/18 SAB Draft Report makes imprudent statements about modelling. The SAB says: "The more complex the model, the greater the dependence of outputs on input assumptions; thus, sensitivity and uncertainty analyses are needed to adequately interpret the results from complex models. Often, simple models are best."

This statement implies that the reference point baseline approach may be both simpler and better which the SAB supports with a citation to Buchholz et al. (2014) which compares the predicted inventory generated from the USDA Forest Service Renewable Planning Act (RPA) models to observed inventory trends. Somehow the Buchholz (2014) article is interpreted to lend support to the SAB's conclusion that: "*Given the challenges in predicting the future status of forest resources, anticipated future baselines might be best suited for planning and policy development, while constant reference baselines might be more appropriate for monitoring and regulatory frameworks.*" We do not see any conceptual relationship between the Buchholz (2014) article comparing predicted forest inventories with observed inventories and the SAB's preference for a

reference point baseline. The SAB authors also note that "an anticipated future baseline might be warranted if there is confidence in predicting future pathways and identifying all relevant carbon pools and drivers" but "a constant reference approach might be preferable if uncertainty in GHG emission drivers, carbon pools and fluxes prevails".

This argument is flawed for several reasons:

1. It is tempting to accept the "simpler is better" solution to a complicated problem. However, a simple model that misses key drivers of the market and behavioral response to a policy may simply provide a false sense of precision but an incorrect assessment. The criteria for model selection should not be the appearance of accuracy and precision in projections because it has a simple theory or few variables that can be measured with certainty. The criteria for selection should be that the model includes functionality and variables that are known to influence future conditions even though the degree of influence are uncertain and the value of the input variables may be uncertain. **The use of a simple model could be inaccurate and give a sense of false precision while a model with more complex theory and relevant variables would be arguably more accurate but less precise**. The second type of model would provide more accurate projections of the difference between a baseline and alternate scenario and an appropriate evaluation of all the sources of uncertainty in this difference.

2. The estimate of a BAF will depend not only on carbon science but also on the scale of market demand for a feedstock which depends, among other factors, on its competitiveness relative to other feedstocks. An integrated modeling approach is required to determine scale of demand for a feedstock, accompanying changes in the use of cropland and forestland, and to attribute additional emissions due to a particular feedstock.

   The Panel's report had therefore noted that "For the task at hand, estimating BAFs, we believe that an integrated modeling approach that captures economic and biophysical dynamics and interactions is appropriate to simulate the "with "and "without" demand scenarios to estimate the additional effect of bioenergy demand on CO_2 emissions. Additionally, given the temporal scale of these impacts, the potentially wide choice of crop-based and forest feedstocks and the spatial heterogeneity in their production conditions, the dynamic model would need to include both the agricultural and the forestry sectors, competition between land using activities, investment decisions that consider potential future returns (especially for slower growing, long rotation feedstocks), and a large number of spatially distinct production regions (while keeping the model tractable)."

   The FASOM model used by EPA for its illustrative BAF estimates in the 2014 Framework has the above features. However, as the Panel noted, there is a need for more model validation, evaluation, justification, and sensitivity analysis to justify its use for estimating BAFs. It should be noted that the goal of the modeling for estimating BAFs is not to obtain a precise and accurate forecast of the future but to assess the *difference* between two scenarios. This would eliminate the effect of uncertainties that affect both the policy and the reference scenario in the same manner.

3. In the case of U.S. forest carbon inventories, creating a quantitative reference point baseline is neither simple nor stable. Figure 2 (from Latta et al. 2018) below shows that not only is the

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current forest carbon estimate subject to large uncertainties, but current and historical estimates shift as data and modeling methods evolve. Thus choice of a reference point is also subject to uncertainties and there is no assurance that baseline values will be measured precisely.

4. The assessment of the additional effects of bioenergy demand using the reference point approach is sensitive to the choice of the reference point. As an illustration, using the reference point approach and 2005 as the reference year, DeCicco et al. (2016) show that biogenic carbon uptake by corn for ethanol is only 37% of biogenic emissions due to ethanol production and consumption and that this makes corn ethanol 28% more carbon intensive than gasoline. De Kleine et al. (2017) show that using 2006 as the baseline reference year instead of 2005 would have changed the estimate obtained by DeCicco et al (2016) from 37% carbon offset to a 138% carbon offset which would make corn ethanol significantly less carbon intensive than gasoline.

5. Updating the reference year does not necessarily correct the problem of determining attribution and additivity. As noted by Gustavson et al. (2000), ".. the baseline cannot be subject to continual revision; it must have sufficient definition that the project is not continually measured against a weakly defined moving target."

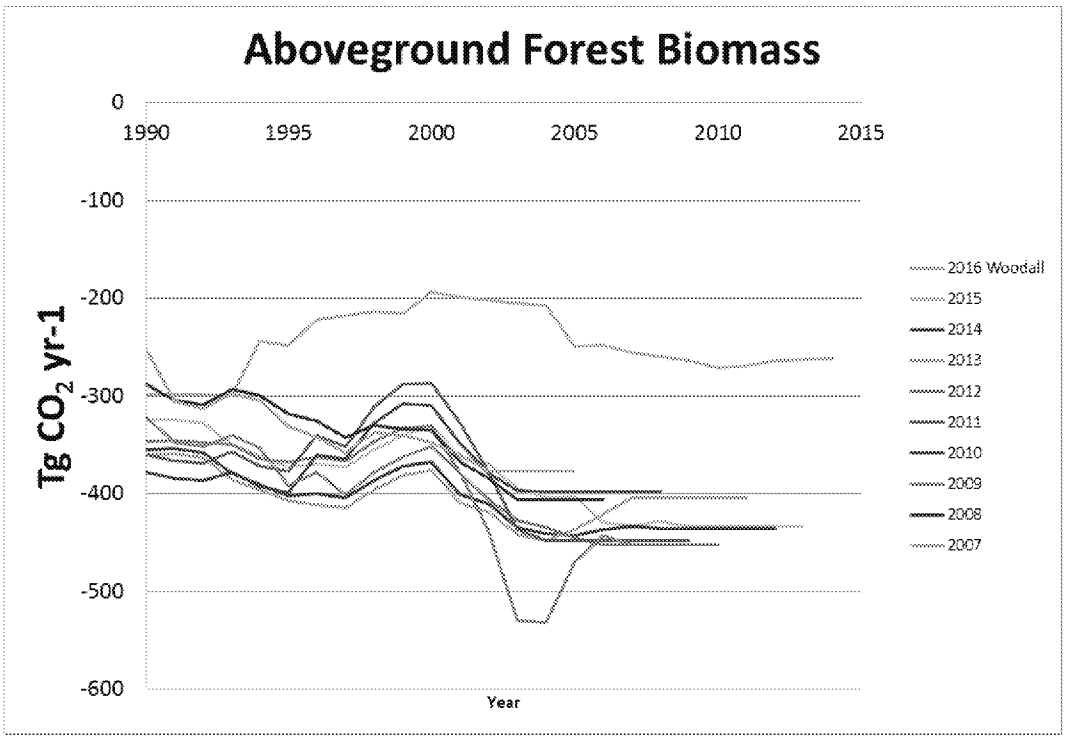

Figure 2: Estimates of Forest Carbon Stocks

Source: Latta et al., 2018
USEPA. 2015. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2013. U.S. Environmental Protection Agency, Office of Atmospheric Programs, EPA 430-R-14-003 , Washington, D.C.
Woodall, Christopher W.; Coulston, John W.; Domke, Grant M.; Walters, Brian F.; Wear, David N.; Smith, James E.; Andersen, Hans-Erik; Clough, Brian J.; Cohen, Warren B.; Griffith, Douglas M.; Hagen, Stephen C.; Hanou, Ian S.; Nichols, Michael C.; Perry, Charles H. (Hobie); Russell, Matthew B.; Westfall, Jim; Wilson, Barry T. (Ty). 2015. The U.S. forest carbon accounting framework: stocks and stock change, 1990-2016. Gen. Tech. Rep. NRS-154. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 49

References

Allen, M. R., Frame, D. J., Huntingford, C., Jones, C. D., Lowe, J. and Meinshausen, M., 2009. Warming Caused by Cumulative Carbon Emissions toward the Trillionth Tonne. Nature 1163-1166.

Buchholz, T., S. Prisley, G. Marland, C. Canham, and N. Sampson. 2014. Uncertainty in projecting GHG emissions from bioenergy. Nature Climate Change 4:1045-1047.

De Kleine RD, Wallington TJ, Anderson JE, Kim HC (2017) Commentary on "carbon balance effects of US biofuel production and use," by DeCicco et al.(2016), Climatic Change 144:111-119

DeCicco JM, Liu DY, Heo J, Krishnan R, Kurthen A, Wang L (2016) Carbon balance effects of US biofuel production and use, Climatic Change 138:667-680

Gustavson, L., T. Karjalainen, G. Marland, I. Savolainen, B. Schlamadinger, and M. Apps. 2000. Project-based greenhouse-gas accounting: guiding principles with a focus on baselines and additionality. Energy Policy 28(2000) 936-946.

Latta, G., J. Baker, S. Ohrel, J. Jones, Spatially explicit downscaling of land use projections to evaluate localized forest mitigation opportunities. Presentation at the 2018 Forestry & Agriculture GHG Modeling Forum. Shepardstown, WV

Matthews, H.D., Gillett, N.P., Stott, P.A. and Zickfeld, K. (2009). The proportionality of global warming to cumulative carbon emissions. Nature 459: 829-832.

USEPA 2018. Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2016. EPA 430-R-18-003. https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf

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2018 SAB review of "Framework for Assessing Biogenic CO2 Emissions from Stationary Sources (2014)"

General: The framework looks at the extent to which production, processing and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions. The report does a good job of detailing what previous reports did and did not address and provides an easier to read review of recommendations compared to the earlier reports.

A key deliberation of the report that addresses problems with the previous version was related to the time horizons selected to estimate bio assessment factors (BAF). The recommendations in the report allows for flexibility in the framework - transient trends in stocks are not easy to capture and therefore adjustments that take place in stocks should be reflected by choosing time frames that are not long. This is the central piece and the recommendation is supported well in the report. Another important suggestion is on the modeling choice which was not requested from the SAB and therefore the report does not address this but does point out that criteria for choosing a model and the sensitivity of the BAF to modeling features must be looked into. The recommendations on page 4 in the executive summary are right in its brevity because of the lack of policy and modeling questions posed by the EPA. I understand that a policy context was specified earlier and removed for the 2014 framework but general guidance on temporal, spatial and production scale was being requested for a policy neutral context.

Without policy considerations, we have ambiguity and default assumptions will not work, especially given the challenges and uncertainties in estimating— rate of afforestation, deforestation, demand for bioenergy, age of trees when harvested, carbon sequestration, all of which add complexity, making it difficult to get baselines and changes from baseline captured right.

Q1: Were the charge questions adequately addressed?
Various charge questions are mostly addressed fairly adequately, especially charge questions 1. Key considerations are where is the demand being met from? Source, type, growth, use are many factors that need to be included in looking at what the carbon change may be. Capturing this is tricky depending on the context. I agree with the recommendation that the cumulative BAF is needed over a time horizon specified by a policy context and must have a few principles defined —such as net change - positive and negative demands— which then needs to be aligned with a policy outcome. In that regard, the recommendation to charge question 1 could be a bit stronger than outlined — cumulative BAF over a policy relevant time period and how one accounts for positive and negative changes could include appropriate caveats which are explained in the text (type of feedstocks, age, harvest and regrowth and such important factors). Just an additional line that includes caveats would suffice.

1a—looks into the science and policy question regarding specifying time horizon without a policy context. Science can tell us what integration over different time horizons mean and this is useful for policy setting. So I think the report rightly looks at that. Rest of the charge questions related to 1, on the temporal and spatial scale are adequately addressed.

On charge question 2 regarding the scale of use and how to appropriately represent change in demand -- BAF is sensitive to feedstock produced so capturing demand changes matter, not sure

how one looks at scale for demand shock without many time and policy relevant details -- the recommendation that BAF for a feedstock reflect methods used to produce the feedstock, not quite easy to follow what it boils down to. An example would be useful perhaps. A recommendation was lacking and perhaps the recommendation could be that the complexities are large and any predictions on scale of demand shock can only be done in a policy context and very challenging to define otherwise. It's a very important question and it might be useful to be more specific in the response, even if it might be similar to that for 2c.

On the request for recommendation on shocks implemented in isolation and aggregate — for 2d to 2e – the suggestion that in the absence of knowing scale one must look for different threshold levels of demand seems reasonable. The rest of the charge questions 2f to 2h are adequately addressed.

Q2: Are there technical errors or omissions or issues that are not adequately dealt with in the draft report?
In an earlier review, the alternate fate approach of waste-derived feedstocks was thought to be not treated well. It is included in this report, but the context and recommendation needs to be elaborated on. As presented it does not fit well, and a recommendation is not included on what needs to be done. Since it is not a charge question, I think it needs some justification/recommendation and should be caveated appropriately.

Q3: Is the draft report clear and logical?
The report is clear and logically presented. I think the exec summary is especially well written and presented in a very readable manner compared to the earlier drafts. In the introduction and response to charge questions some of the same statements from the executive summary are not always in the body. Some more details on why technology/production characterization is needed for looking at demand scale for Q2, and for Q1 landscape versus stand approach, etc. could be included in the responses. These are discussed but it sometimes feels like the next step on what that might mean is not stated.

Q4: Are the conclusions drawn or recommendations provided supported by the body of the draft report?
Yes, the conclusions and recommendations are mostly supported by the body of the draft. In some instances, an elaboration of the recommendation or supporting caveats for the conclusion would help strengthen the recommendations.

Mr. Thomas Carpenter
Designated Federal Officer
EPA Science Advisory Board Staff Office (1400R)
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, DC 20460

Dear Mr. Carpenter:
I am writing as a past researcher of carbon cycle science, carbon accounting, and carbon flux from terrestrial ecosystems. I also served as a member of the EPA Panel on Biogenic Carbon Emissions that provided input on the first two draft Frameworks.

I believe that the *draft SAB review* of the EPA's Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources summarizes the panel discussions and outcomes well, given the different scientific perspectives on a few of the issues. I generally support the logical conclusions of the *draft SAB review* on all five recommendations made on page 4 of the review document.

I would like to reiterate support, with additional explanation, for one of these findings. Key Finding number 2 is significant. The first framework tried to sum all the emissions (i.e., sum fluxes). This was not efficient and was prone to inaccuracies. The second framework switched to a stock-change approach, guided by methods of carbon accounting that have been implemented nationally and internationally. This type of approach coincides with approaches in the United States like the Forest Inventory Analysis. It is more straight forward and less prone to error. More importantly, it captures the overall changes in standing stock over a given region and a given time period. This finding is significant, because the change in standing stock due, for example, to a doubling in harvest over the US, may or may not be carbon neutral over a given time, depending on regrowth rates, land-use change, and rotation intervals. For example, if we double the national harvest, and if the harvest rates remain at that new level, the stock may theoretically decrease and remain lower until the harvest rates change again. Therefore, over the biophysical lifetime of the tree or forest stand, a tree or forest stand is carbon neutral in the long-term. However, over a landscape scale (e.g., sub-national or national), the impact of new forest policies may not be carbon neutral, even over the long-term. The stock-change approach would capture that reality, just as it does in the U.S. Forest Inventory Analysis program.

In conclusion, I think that the review of the SAB is sound and that regional BAFs for a number of biomass energy sources could be estimated in a relatively straight-forward manner by experienced researchers in core relevant disciplines, and done so by <u>not</u> including the complexities and highly uncertain factors that are interesting for complex research analyses but not necessarily fitting for regulatory frameworks.

Sincerely,

Tristram O. West, Ph.D.

Message

From: Smith, Anne [Anne.Smith@NERA.com]
Sent: 12/18/2018 9:42:05 PM
To: Larry Monroe [Ex. 6 - Personal Privacy]@gmail.com]; Michael Honeycutt [Michael.honeycutt@tceq.texas.gov]; Steven Hamburg [shamburg@edf.org]; Larry Monroe [drlarrymonroe@gmail.com]; Carpenter, Thomas [Carpenter.Thomas@epa.gov]
CC: Brennan, Thomas [Brennan.Thomas@epa.gov]; Johnston, Khanna [Johnston.Khanna@epa.gov]; Matthew Welch [mwelch@edf.org]
Subject: RE: Biogenic Carbon Emissions Report - Review and comments
Attachments: Biogenic Carbon-8-29-18 12-16-18 edits Monroe edits_Smith edits.docx

All,
I'm attaching my own edits, which I have done as redline ON TOP OF LARRY's version from earlier today. Thus, you will see Larry's redlining in here as well as my own. I have added margin notes in a few places to explain the reason for making certain edits. I only did this where it seemed that some explanation would be appreciated by you all. Although I have managed to get all the way through the document today, and I believe that most of my original comments are now addressed (if my and Larry's edits in the attached are accepted) I remain concerned that the part where specific charge questions are being answered is not actually answering the questions. I didn't edit with that issue in mind. I'll try to take time to see if those issues might have been addressed during Steve and Jeanne's revisions. Overall, I think the points about the need for more regulatory specificity are being stated in a way that outside readers will be more likely to understand, and I do appreciate Larry's realization that the right word is regulatory not policy…that alone helped a lot in my ability to make sense of what the review was trying to say.
--Anne

From: Larry Monroe [Ex. 6 - Personal Privacy]@gmail.com>
Sent: Tuesday, December 18, 2018 11:42 AM
To: Michael Honeycutt <Michael.Honeycutt@tceq.texas.gov>; Steven Hamburg <shamburg@edf.org>; Larry Monroe [Ex. 6 - Personal Privacy]@gmail.com>; Carpenter, Thomas <Carpenter.Thomas@epa.gov>
Cc: Smith, Anne <Anne.Smith@NERA.com>; Brennan, Thomas <Brennan.Thomas@epa.gov>; Johnston, Khanna <Johnston.Khanna@epa.gov>; Matthew Welch <mwelch@edf.org>
Subject: RE: Biogenic Carbon Emissions Report - Review and comments

Sorry that this is later than I intended.

I accepted all the changes in the version that Steve sent, just to show the three explanations that I propose to be inserted to help the readability. I will rely on Blaise Pascal's quote for my inability to craft a single sentence that could be replicated in three places in the document – they are all longer than that.

I have made this longer than usual because I have not had time to make it shorter.
Blaise Pascal, 1657

I also attempted to make the document more specific by liberal substitute of "regulatory" for "policy". In my mind, regulatory more narrowly describes what the document is trying to say. That is, BAFs may be vastly different for two regulatory schemes, while they both may fall under the same policy of reducing emissions of greenhouse gases.

Definition 2b in Merriam-Webster of policy states:

a high-level overall plan embracing the general goals and acceptable procedures especially of a governmental body

https://www.merriam-webster.com/dictionary/policy

where, regulation is defined (also as 2b) as

a rule or order issued by an executive authority or regulatory agency of a government and having the force of law

https://www.merriam-webster.com/dictionary/regulation

Forgive my presumption, but I believe that this makes the document much clearer and specific. Let me know your comments.

Anne Smith has only briefly seen these, so I invite her edits also. I will continue to work on the main document also.

Let me know if there are questions or comments.

Thanks,
Larry

DATE

EPA-SAB-19-xxx

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Subject: SAB review of *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014)

Dear Acting Administrator Wheeler:

The EPA Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014) ("2014 Framework"). The 2014 Framework considers the scientific and technical issues associated with accounting for emissions of carbon dioxide (CO_2) from biogenic feedstocks used at stationary sources.

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for CO_2 emissions associated with the combustion of biogenic feedstocks at stationary facilities by accounting for the biological carbon cycle effects associated with growth, harvest, and processing of these feedstocks. The BAF is an accounting term developed by EPA to adjust stack emissions to reflect a feedstock's *net* carbon emissions after accounting for subsequent sequestration of carbon in regrown biomass or soil, and after considering emissions that might have occurred with an alternate fate had the biomass not been used for fuel.

The SAB notes that EPA's 20124 Framework may be used to develop BAFs for multiple regulations and associated climate objectives (e.g., total emissions versus temperature, etc.) ~~and resulting regulations,~~ ~~and~~it therefore ~~it~~ must ~~consider~~be able to accommodate a wide range of potential time and spatial scales and ~~-~~all relevant GHGs~~, and policy goals (i.e., total emissions versus temperature, etc.) in order to calculate specific BAFs.~~ Lack of specificity in the BAF objectives to be addressed under the Framework~~applicable to that objective, making~~has made it difficult for the SAB to address many of the charge questions fully.

EPA's 2014 Framework is a revision of its 2011 Framework, which the SAB previously reviewed. The SAB notes that the 2014 Framework incorporated some of the SAB's prior advice and advanced the analytical foundation for making determinations about the net contribution of biogenic feedstocks to CO_2 in the atmosphere. Specifically, the 2014 Framework has incorporated the SAB's prior advice as follows:

- It has adopted an alternative fate approach (i.e., a counterfactual evaluation of what the net biogenic atmospheric contribution might have been if the feedstocks were not used for energy) to the collection and use of waste-derived feedstocks, including avoided methane (CH_4) emissions.
- It includes a discussion of the trade-offs inherent in the selection of a temporal scale for considering net emissions.
- It has developed representative BAFs by feedstock and region rather than facility-specific BAFs.
- It includes a review of existing approaches to addressing leakage, the phenomenon by which efforts to reduce emissions in one place affect market prices that shift emissions to another location.
- It offers an approach to construct an anticipated baseline that allows assessment of the additional CO_2 emissions to, or uptake from, the atmosphere that can be attributed to biogenic feedstocks as a result of changes in biomass feedstock demand.

The 2014 Framework does not, however, provide the ~~policy-~~regulatory context, specific BAF calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. The BAF is a *construct* designed to evaluate the importance of the stack emissions of CO_2 at a given time relative to their climate impacts at some point in the future when some of the emitted CO_2 may have been sequestered by regrowth of biogenic feedstocks. As such, the computation of the BAF for a feedstock in a region depends upon the climate impact of concern and the future point in time that is of interest, which is a choice that depends upon the ~~objective of interest~~specific regulation that will rely on that BAF. If the objective of interest for the BAF computation is defined by short term processes, then the relevant time-period for the BAF computation needs to ~~be consistent~~include relevant details on short term climate phenomena, which might be less important if the objective of interest is much longer term. In addition to ~~providing~~ identifying ~~details on the objective to inform~~ the relevant analytic time frame, ~~a policy regulatory context~~knowing the objectives of interest would ~~have~~ provide~~d~~ other information necessary to the assessment of the science underpinning the BAFs, such as the scale of demand for biogenic feedstocks, ~~and~~ the anticipated time frame for that demand and eligible feedstocks to meet it, relevant spatial scope, and importance of including each type of GHG in the analysis. ~~Policy-Regulatory choices are expected to affect actions taken in feedstock markets, and these anticipated actions affect the assumptions in the models used to compute the BAF.~~

Commented [SA1]: I suggest deleting the last sentence because it does not seem to relate to how the regulatory context affects the scope of the BAF calculation. It is true a factual matter but it does not further the point of this paragraph. Deletion is the easy fix, and it doesn't make a point on its own that seems important to the SAB's evaluation of the framework.

While the SAB agreed with many of the recommendations developed by the Biogenic Carbon Emissions Panel in previous drafts of the report, it disagreed with the extended time frame recommended for BAF computation. There was ~~extended much~~ discussion between the SAB and the Biogenic Carbon Emissions Panel over the significance of the time horizon used to calculate BAFs. The Panel recommended that a general principle for determining the time horizon for BAF calculations should be to select a time horizon that fully accounts for the temporal dynamics for all feedstocks to accommodate the Agency's preference for a regulatory-tion~~policy~~-neutral approach. During quality reviews the SAB disagreed with this recommendation noting that for regulatory~~policy~~ initiatives that focus on objectives that reflect shorter time horizons, a general model with a long time horizon ~~it~~ may not ~~accurately~~ adequately capture the net carbon dioxide emissions relevant to ~~that policy-regulation if a BAF is calculated to incorporate nearly all carbon stock effects over a much longer period of time.~~ the nearer-term outcomes. The SAB favors selecting the time horizon for calculating the BAF to comport with the

objective under consideration, which is generally ~~incorporated into~~dependent on the ~~regulatory policy choice~~regulation mandating use of that particular BAF. The Panel's previous reports remain available on the SAB [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252?OpenDocument"].

As we stated in our 2012 report and we reiterate here: this SAB review would have been enhanced if the Agency offered a specific regulatory application that, among other things, provided explicit proposed BAF objectives, which would in turn ~~calculations and~~ have defined the applicable boundaries regarding upstream and downstream emissions in the feedstock life cycles. The 2014 Framework lacks specificity and is written in a way that is too generic, with too many possibilities that would require assessment of different underlying science. Rather than offering a lengthy menu of calculation options, the EPA Framework needs to define its scenarios and justify those choices. This would enable the SAB to evaluate the science underpinning those decisions and justifications.

Despite this significant limitation, the SAB offers overarching suggestions for moving forward with a framework for assessing the BAFs of biogenic feedstocks. In addition we offer specific responses to EPA's charge questions when possible, the SAB offers general guidance regarding the calculation of BAFs. EPA's equations were based on emissions (fluxes) with some adjustment terms to account for carbon mass escaping the system between the point of assessment and the point of emissions. In the enclosed report, the SAB recommends an alternative formulation based on changes in terrestrial (non-atmospheric) carbon stocks (or pools) such as the live stocks in biomass, dead stocks, soil stocks, etc., that explicitly incorporates the principle of conservation of mass. While the carbon-stock-based accounting system results in a ~~similar~~ formula for BAF similar ~~as~~ to that of ~~the~~ EPA's emissions-based approach, it offers multiple advantages: the component stocks are regularly inventoried and modeled by the scientific community; the different stocks can be aggregated and rearranged as needed or further subdivided; and it is appropriately constrained by conservation of mass and therefore the ~~precision~~ validity of the results can be assessed using mass balance calculations. Although this alternative formulation provides these benefits, other important modeling issues remain. These include selecting appropriate temporal or spatial boundaries, considering variability among classes of feedstocks, accounting for non-CO_2 greenhouse gases such as nitrous oxide and methane, and quantifying stocks and fluxes that are difficult to measure or estimate.

Commented [SA2]: Something is wrong with this sentence, but I don't have enough knowledge of the prior versions to suggest edits to fix it.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for ~~carbon dioxide~~CO_2 related to the use of biomass for electricity generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. We offer this caution about the model boundaries as defined by EPA's method and identified in the SAB review. In addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a whole different analysis and ~~policy~~regulatory policy response.

Commented [SA3]: I think this is one of the few spots where "policy" is more appropriate than "regulatory"

Finally, EPA did not ask the SAB for feedback on its modeling approach. We think this was an oversight, given that modeling is critical to the development of the BAF and different modeling approaches can yield different results. The 2014 Framework employed an integrated model that captures economic and biophysical dynamics and interactions for some of its alternative BAF calculations; however, EPA did not offer explicit justification for its modeling choices derived from articulated criteria. In addition, the sensitivity of BAF responses to some underlying features of the model was not

examined by the EPA or the SAB. Thus, we conclude EPA should identify and evaluate its criteria for choosing a model or models and examine the sensitivity of BAF estimates to key modeling features.

The SAB appreciates the opportunity to provide advice on the 2014 Framework and looks forward to your response.

Sincerely,

Enclosure

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board (SAB), a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The SAB is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names of commercial products constitute a recommendation for use. Reports of the SAB are posted on the EPA Web site at [HYPERLINK "http://www.epa.gov/sab"].

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Mr. Thomas Carpenter, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board, Washington, DC

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Acronyms and Abbreviations

AVOIDEMIT	Avoided Emissions
BACT	Best Available Control Technology
BAF	Biogenic Assessment Factor
BAU	Business as Usual
CH4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DOE	Department of Energy
EPA	Environmental Protection Agency
FASOM	Forestry and Agricultural Sector Optimization Model
GHG	Greenhouse Gas
GROW	Term in EPA's BAF equation representing net feedstock growth (or removals)
GWP	Global Warming Potential
PSD	Prevention of Significant Deterioration
N_2O	Nitrous Oxide
SAB	Science Advisory Board
USDA	U.S. Department of Agriculture

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1. EXECUTIVE SUMMARY

The EPA requested the SAB review a revised framework for accounting for biogenic carbon emissions, which the agency defines as "CO_2 emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, digestion, fermentation, decomposition, or processing of biologically based materials."[1] The goal of the 2014 Framework was to evaluate biogenic CO_2 emissions from stationary sources that use biomass feedstocks, given the ability of green plants to remove CO_2 from the atmosphere through photosynthesis. The 2014 Framework and its 2011 predecessor introduced the concept of a Biogenic Assessment Factor (BAF), which is the proposed adjustment for carbon emissions associated with the combustion of biomass feedstocks. The BAF is an accounting term developed in the Framework to denote the offset to stack emissions (mathematical adjustment) to reflect net carbon emissions after taking into account the sequestration of carbon in regrown biomass or soil, as well as emissions that might have occurred with an alternative fate had the biomass not been used for fuel.

Importance of Defining the **Objective**s ~~through the Policy~~~~Regulatory Context~~to Be Addressed by a BAF

The questions before the EPA in 2011 and presented for the SAB's review, were whether and how to consider greenhouse gas (GHG) emissions and decisions about best available control technology (BACT) for CO_2 emissions from biomass feedstocks used for electricity generation at stationary facilities. EPA proposed to address this issue by defining a term, Biogenic Assessment Factor, intended to be used to assess effects *relative* to the desired objectives. The 2014 Framework, ~~:~~ however, removed the ~~policy~~regulatory context, and did not include specific BAF calculations for any ~~policy~~regulatory context, or the implementation details the SAB previously requested. ~~In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. Thus, evaluation of this construct for a science-based regulatory framework in the absence of the defined objectives is not useful. Rather than assume a set of objectives (articulated in a policy~~regulatory~~ context) or evaluate the charge questions across numerous putative objectives of interest, the SAB focused on providing input on considerations that affect the usefulness and scientific integrity of EPA's approach.~~

~~The SAB notes that~~Because the EPA's 20124 Framework report does not identify the specific metric of climate impact (or "objective") with resulting regulations that a BAF estimate should reflect, ~~and further notes that~~ BAFs that may be developed under the Framework could entail a wide range of objectives, e.g., temporal and spatial domains, total emissions, temperature, etc. While ideally it ~~may~~would be desirable to identify a universal methodology that could be applied to any of a wide range of potential objectives, doing so poses exceptional technical challenges and the concept was not endorsed by the SAB. Thus, the lack of specificity in the 2014 Framework document regarding the objectives that BAFs under it are expected to ~~to be estimated~~addressd makdes it very difficult for the SAB to assess whether the ~~suggested~~ types of models, data, and baselines suggested by the Framework are appropriate, and ~~this~~has limit~~s~~ed the ability of the SAB to fully address some of the charge questions. We thus preface

Commented [SA4]: My edits here are just to better integrate Larry's new parag (mainly rearranging text within this section) I like the added material by Larry because I think it helps a reader lacking the history of these deliberations to better understand the points that were being made here originally.

Commented [SA5]: I added this based on what I think I've learned from reading sections above -- that the panel was more in favor of this concept than the SAB. If I have this history wrong, my edit here can be removed.

[1] [HYPERLINK "https://19january2017snapshot.epa.gov/climatechange/carbon-dioxide-emissions-associated-bioenergy-and-other-biogenic-sources_.html"]

the SAB's comments with this observation on the consequences of having made this revised 2012~~4~~ Framework so ~~general~~unspecific with respect to ~~in~~ its intended and potential applications. The SAB concluded that evaluation of EPA's plan for a science-based regulatory framework in the absence of defined regulatory objectives is not useful. Rather than assume a specific objective, or evaluate the charge questions across numerous putative objectives of interest, the SAB has focused on providing input on considerations that affect the usefulness and scientific integrity of EPA's approach in general.

Region- and Feedstock-Specific Biogenic Assessment Factors, baselines and modeling

As recommended previously by the SAB, BAFs should be feedstock-specific and region-specific and not facility-specific. Facility-specific BAFs are conceptually and practically challenging to estimate due to the absence of well-defined spatial boundaries for feedstock supply to each facility and the role of market-induced effects on land use, on biomass production and market demand for fiber, and on carbon stocks across space. To obtain a region-specific BAF for feedstocks, it is necessary to address region-specific, feedstock-specific demand for biomass and to assess the impact of this increased demand for biomass on net carbon stocks. Changes in demand for biomass feedstocks should be assessed based on historical data on forest carbon stocks, resource use, and observed information on current and planned expansions to facilities using biomass feedstocks. *There is no single answer to what these BAFs should be, as not all biogenic emissions are carbon neutral nor net additional to the atmosphere, and assuming so is inconsistent with the underlying science.*

Projections of the interactions that must be assessed to compute a BAF can be obtained from diverse model types, from simple empirically and statistically-based models, to complex integrated assessment models that combine biophysical and economic factors. ~~The m~~More complex ~~the~~ models may be necessary to capture key economic or physical phenomena required of a BAF, but more complexity can also, ~~the greater the dependence of outputs on input assumptions and available data, which may~~ limit the ~~applicability~~ accessibility of these models to all relevant parties, make them challenging to understand, and make their results difficult to evaluate. This will be a fundamental challenge in developing acceptable BAF estimates for most types of objectives. However, ~~f~~For all model types, sensitivity and uncertainty analyses are needed to adequately interpret the results and understand the dependency of the BAF on the choices and assumptions used as part of its computation.

Commented [SA6]: I feel strongly that the suggestion that complex models are more dependent on assumptions than less complex ones should be eliminated. The rest of my edits here are to fill in the gap with statements about complex models that are valid.

To compare changes in any system over time there must be a reference scenario (without increased demand for biomass feedstocks) against which to assess the net impacts on the variable of interest. In 2012, the SAB recommended a future anticipated baseline approach to capture the *additional* CO_2 emissions to, or uptake from, the atmosphere created by any increased use of biomass feedstocks for electricity generation. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis *along with* a reference point approach in its 2014 Framework. Both the future anticipated baseline and the reference point baseline (with regular updates) are challenging to apply due to data and modeling limitations.

Regardless of the baseline structure chosen (adjusted reference or future anticipated), validation and evaluation of the model used to compute the BAFs will be critical. Model validation is essential to

assessing any model's ability to replicate observed phenomenon over time, ensuring that simulations based on the model are ~~capturing~~ projecting ~~expected~~ logical and reasonable patterns of behavior in the system. Similarly, understanding model sensitivity to input parameters and assumptions is important with respect to assessing model applicability over time. The model selected for estimating BAFs should be reviewed and updated at regular intervals, capturing observed changes in economic and land use conditions that may be due to increased biomass demand or other related conditions, as well as the latest scientific information on biophysical and biogeochemical properties of feedstocks. The appropriate review interval should be selected based on the timeframe of the ~~policy~~regulatory objective(s) as well as the timeframe associated with updates to the underlying data.

Charge Question 1

Temporal and Spatial Scales

A sustained increased demand for biomass feedstocks by stationary facilities in a region is likely to trigger changes in carbon stocks through one or more pathways that could generate a new (steady-state) equilibrium stock of carbon that may be higher or lower than the current stock of carbon on the land. The demand for biomass feedstocks for use in stationary facilities can affect carbon stocks by increasing harvesting intensity for standing biomass, diverting biomass feedstocks from other non-energy products and landfills, converting land from other uses to plant new biomass feedstocks for the future, and utilizing biomass residues that might otherwise decay. Each of these responses may differ over time, and thus, the overall effect of all these responses together on demand for biomass feedstocks may differ over time. Therefore, the time period selected for ~~the analysis can strongly affect the assessed~~estimating the carbon stock or net carbon emissions impacts of an increased demand for biomass feedstocks ~~by stationary facilities on carbon stocks and net emissions of carbon dioxide to the atmosphere~~can strongly affect that estimate. The selection of the time period for assessment is not a purely scientific question, ~~but rather is closely~~and may be driven primarily by ~~associated with~~ the objectives specified in the regulation that mandates use of BAFs to be estimated using this Framework~~policyregulatory objectives being addressed by the application of a feedstock-specific and region-specific BAF to a facilit(y/ies)~~. For example, consider an objective to limit peak planetary warming versus an objective of controlling emissions of greenhouse gases in 2050: the same feedstock in the same region could have widely varying impacts on terrestrial carbon stocks because the timeframe defining the endpoint of the relevant analysis would differ. Since BAFs ~~are~~ will computed ~~by assuming a~~to serve specific ~~policy~~regulatory objectives, there are no scientific criteria by which to pick a single 'right' timeframe for their determination independent of their ~~policy~~regulatory context (Ocko et al 2017).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for ~~the~~ this application ~~EPA defines (stationary facility for energy production)~~. A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks

Stock-Based Accounting Preferred to Emissions-Based Accounting

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Carbon accounting associated with determining BAFs should be based on changes in carbon stocks on the land rather than changes in carbon emissions (as used in EPA's 2011 and 2014 Frameworks). A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated, subject to validation via mass balance and an existing comprehensive system of empirical measurements is already in place for the US. The stock-based approach comports with the current conventions in carbon accounting, which essentially use input-output tracking of carbon throughout a system with well-defined boundaries. These stocks can be aggregated and rearranged as needed, and they are appropriately constrained by conservation of mass and therefore can ~~be assessed and precision determined~~checked for validity using mass balance calculations, in addition to other checks.

policy

Two Cumulative Biogenic Assessment Factor Approaches

Computing a cumulative BAF over any period of time requires accounting for the positive and negative impacts on stocks over time to determine the net effect on those stocks. A cumulative BAF is preferable to an instantaneous (or annual) BAF because the use of biomass feedstocks can cause changes in carbon stocks that manifest beyond the period in which the feedstock is consumed by a stationary facility. There are two alternative approaches to calculating a cumulative BAF and the implications of these different approaches should be further considered. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach as applied to stocks, i.e., the difference in carbon stocks *at the end of the selected time horizon*. A second approach was developed by members of the Biogenic Carbon Emissions Panel; it considers the time course of CO_2 emissions by accumulating the annual differences in carbon stocks on the land *over the time horizon until equilibrium is reached*. By accumulating annual differences across the projection period, the alternative cumulative BAF metric (which the panel designated as BAF_{CT}) attempts to incorporate "residence time" in the sense that it is a proxy for the length of time carbon stays in the atmosphere until it is modified by changing stocks of carbon on the land. While intended to generate a single BAF term at the end of the selected time horizon, either computation can be evaluated at any time of interest.

Commented [SA7]: It seems an entire section was deleted here between Sunday evening's draft and Larry's version. I've just copied it back in below from the Sunday version, and I've made no edits to it from the Sunday night version. I think Larry had said he was going to try to clarify this parag a bit, but if so, we'll need to get them from him – they aren't in this version.

Charge Question 2

Scales of Biomass Use and Modeling Approach

Projections for aggregate demand for all biomass changes should be bounded by historical data on resource use, observed information on current and planned expansions to facilities using biogenic feedstocks, and reasonable projections of cost-effective deployment of biomass feedstocks for meeting the energy/feedstock needs of stationary facilities.

In addition, regular retrospective evaluations of observed levels of demand and the mix of feedstocks would enable revisions to EPA's estimates of feedstock demand. Retrospective evaluations of BAF performance will be important for understanding how effective the modeling has been in predicting what occurred. Thus, projections about biomass feedstock demand should be revised based on actual observations, and these updated demands should be used to inform modeling that generates BAFs.

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Recommendations

~~1.~~ As we have observed above, a sound~~An accurate~~ biogenic carbon accounting approach ~~utilizing~~for estimating BAFs ~~Biogenic Assessment Factors~~ will ~~vary~~ depend~~ing~~ on the specific regulatory ~~-~~objectives for those BAFs, which are yet to be defined. Recognizing this limiting factor in the SAB's ability to review the 2014 Framework, we make the following recommendations ~~for their development, which depend upon the policy~~regulatory ~~context, particularly in selection of the time horizon and geographic scope~~.

~~2.~~ 1. EPA should identify and evaluate its criteria for choosing a model and modeling features that affect BAF results. EPA should explore the sensitivity of BAFs to different modeling approaches, assumptions, transaction costs, and uncertainties in model input parameters.

~~3.~~ 2. Stationary facilities require a continuous supply of biomass feedstocks, thus a landscape approach is appropriate and likely most reliable ~~required~~ for accounting for the impacts of feedstock demand on carbon stocks."

~~4.~~ 3. The estimate of the direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no ~~single~~ optimal time horizon for evaluating these impacts, and it may be primarily determined by the regulation mandating use of BAFs.

~~5.~~ 4. Changes in carbon stocks (e.g., live and dead biomass, soil, products, material lost in transport and waste), should be used to account for biogenic carbon, rather than an emissions (flux-based) approach.

~~6.~~ 5. The SAB suggests exploration of two cumulative BAF metrics. Until the implications of the different metrics are clear, the SAB recommends using the metric proposed by EPA, i.e., net changes in stock over a specified time.

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2. INTRODUCTION

2.1. Background

EPA's Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (U.S. EPA 2014).

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for CO_2 emissions associated with the use of biogenic feedstocks in stationary facilities, taking into account the biological carbon cycle associated with the growth, harvest, and processing of plant biomass. This mathematical adjustment to stack emissions is needed because of the unique ability of biological systems to sequester CO_2 from the atmosphere through photosynthesis in living biomass, to sequester carbon in dead biomass and soil, and to release CO_2 through respiration and biologically-mediated decay of organic matter. These attributes of ecosystems mean that there can be wide variation in the net effect of using biomass feedstocks in stationary facilities on emissions of carbon dioxide to the atmosphere and thus it is scientifically indefensible to assume all bioenergy has no net carbon dioxide emissions to the atmosphere, or the reverse, that all emissions represent a net addition to the atmosphere. The ~~Biogenic Assessment Factor~~BAF is an accounting term developed in the Framework to estimate the net CO_2 emissions to the atmosphere over a specified period of time associated with burning biomass feedstocks to produce energy. These net emissions reflect the changes in carbon stocks of above and below ground biomass (live and dead), soils, and wastes. The 2014 Framework is a revision of the 2011 Framework (U.S. EPA 2011), which the SAB previously reviewed (U.S. EPA SAB 2012).

The EPA's charge to the SAB (Appendix A) requests advice and recommendations on its revised 2014 Framework, which was developed with consideration of the SAB's 2012 recommendations as well as the latest information and input from the scientific community and other stakeholders. The EPA asked the SAB to review and offer recommendations on specific technical elements of the 2014 Framework for assessing the extent to which the production, processing, and use of biogenic feedstocks at stationary facilities results in net emissions of CO_2 to the atmosphere so that it could be quantified through calculation of a BAF. ~~The 2014 Framework does not, however, provide the policy/regulatory context-specific Biogenic Assessment Factor calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks.~~

Commented [SA8]: just moving this text to integrate it with Larry's added parag below.

To conduct the present review, the SAB Staff Office reconstituted the Biogenic Carbon Emissions Panel (Appendix B), which had reviewed the 2011 Framework. That panel met multiple times between March 2015 and August 2017. The Panel presented a draft report (February 2016) to the SAB for quality review. The SAB quality review was conducted in March 2016; this quality review resulted in requested revisions from the Panel. The revised draft report (June 2017) was reviewed by the Board in 2017. The 2017 revision of the report was not approved by the SAB based on the deliberations of the quality review. The present report is a product of SAB's direct efforts and utilizes portions of the Panel's report. Previous drafts of the Panel's report are retained on the SAB website and available [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235dac747c16fe985257da90053f252!OpenDocument&TableRow=2.2" \l "2."].

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The 2014 Framework does not provide the regulatory context, specific BAF calculations for that context, or the implementation details the SAB requested in its review of the 2011 Framework. That is, ~~The SAB notes that~~ EPA's ~~2012~~ Framework report does not identify the specific metric of climate impact (or "objective") that a BAF estimate should reflect, and further notes that BAFs that may be developed under the Framework could entail a wide range of objectives, depending on the regulation or policy-specific approach that would require use of a BAF. (For example, some regulations may impose objectives related to different time horizons than others; similarly, under some regulations the BAF may need to address a temperature impact objective, while other regulations may impose a net CO_2 emissions objective.) Any BAF must be estimated using a model that has the scope and temporal detail necessary to simulate the key economic, emissions and atmospheric phenomena to relevant to predicting that BAF's objective. Lack of specificity in the Framework document regarding the objectives to be estimated makes it very difficult for the SAB to assess whether the suggested types of models, data, and baselines are appropriate. While it would, in this situation, be desirable to identify a universal modeling methodology that could be applied to any of a wide range of potential objectives, this poses significant new analytical and data challenges on the Framework, and the SAB is not endorsing such an approach. Thus, we note as a preface to this set of SAB comments that a consequence of having made the 2014 Framework so general in its potential applications is that it has ~~It also~~ limited ~~the ability of the~~ SAB's ability to fully address ~~some of~~ the charge questions presented to it for this review. ~~We thus preface the SAB's comments with this observation on the consequences of having made this revised 2012 Framework so general in its potential applications.~~

3. OVERARCHING COMMENTS

This section addresses issues that lie outside the scope of EPA's charge questions, but which the SAB considered critical to place the responses to the charge questions in context. The charge questions are narrowly focused on specific technical aspects in the structure of the 2014 Framework. However, the SAB had important general advice regarding the Framework. This first section outlines that advice.

3.1. Defining Objectives through the ~~Policy~~Regulatory Context

For its review of the 2011 Framework, the SAB requested and was given a ~~policy~~regulatory context for use of BAFs that would result from the biogenic CO_2 accounting framework. The SAB was told that the 2011 Framework was intended to guide the determination of CO_2 emissions from regulated stationary sources under the Clean Air Act, specifically those facilities receiving a prevention of significant deterioration (PSD) air permit and that were required to conduct a best available control technology (BACT) analysis for CO_2 emissions. The question before the agency, and hence the SAB, was whether and how to consider biogenic greenhouse gas (GHG) emissions in reaching thresholds for permitting and decisions about BACT for CO_2 emissions from the use of bioenergy in stationary facilities.

The agency has removed this ~~policy~~regulatory context from its 2014 Framework, and the EPA's charge questions seek ~~general~~ guidance on issues related to the choice of temporal, spatial and production scale for determining BAFs in a ~~policy~~regulatory-neutral context. In the absence of a specific ~~policy~~regulatory context, which would ~~provide~~ define the objectives ~~against~~ that ~~which the~~ a BAF ~~will be evaluated~~must estimate, ~~this~~ the SAB limited its review ~~was limited~~ to providing general comments about how to consider the questions posed. More specific answers to the questions posed will vary with the objective (as defined by the ~~policy~~regulatory context), most notably the appropriate time period over which to determine the net biogenic emissions, and to a lesser degree, the appropriate geographical scale for consideration.

A ~~policy~~regulatory context with explicit objectives would clarify if the ~~proposed~~ procedures for determining the BAF will need to account for the emissions of all greenhouse gases that alter the climate. If this is the case, then it will be important that the analytic methods described by the Framework ~~to~~ account for the effect of biogenic feedstocks on non-CO_2 gases such as N_2O and CH_4 and ~~,~~ to examine how the emission or uptake of these gases differ across space, time, and feedstocks~~, and to examine how these gases influence BAFs~~. Given the large difference in the mean residence time of these gases in the atmosphere, their relative importance can vary widely over different time horizons. If ~~the~~ climate impacts over 20 or 40 years ~~is of concern~~is the objective, then methane and carbon particulate emissions could be very important, while if the objective's period of concern is hundreds of years, their importance will drop significantly (Shoemaker, et. al., 2013). Non-CO_2 gases are particularly important for feedstocks grown with nitrogen fertilizer and for waste materials from landfills.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for carbon dioxide related to the use of biomass in stationary facilities for energy generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. If, for example, biomass pellets were sourced from old growth forests, this would pose unique risks that would not be reflected in a BAF calculated for net effects on carbon dioxide. We offer this

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caution about the model boundaries as defined by EPA's method and identified in the SAB review. In addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a different analysis and ~~policy~~regulatory response.

Recommendation

- ~~Biogenic Assessment Factors~~BAFs will vary depending on their specific objective~~s for their development~~, which will depend upon the ~~policy~~regulatory context, particularly in selection of the time horizon and geographic scope. Thus, future efforts to define specific biogenic accounting factors should be conducted in a ~~policy~~regulatory-specific context, with the objectives and relevant time frame specified.
- It is inappropriate to use default assumptions, including assuming there are no net emissions or that all emissions are additive.

Commented [SA9]: This seems like a separate recommendation, so suggest separating it into a sencond bullet.

3.2. Baseline Approach

To compare change in any system over time, there must be a baseline scenario against which to assess changes, in this case, changes due to demand for biogenic feedstocks; a baseline allows different scenarios to be compared. In the 2011 Framework, the EPA assesses the estimated net change in land-based biogenic CO_2 fluxes and/or carbon stocks between two points in time, with the first time point called the reference point. In the 2012 SAB report, we noted temporal problems with the reference point baseline approach. The EPA has acknowledged this in its 2014 Framework and included a future anticipated baseline analysis alternative along with a reference point baseline approach. The 2014 framework notes that the choice of baseline (reference point or anticipated) depends on the question to be answered and the specific context in which the framework is applied.

The SAB's 2012 advice on the anticipated baseline approach explored the use of complex modeling in order to try to capture interactions among the market, land use, investment decisions, and emissions and ecosystem feedbacks, and to construct a counter-factual scenario that does not include increased bioenergy use. In the case of long rotation feedstocks, biomass feedstock demand can affect carbon stocks in many ways including the age of trees harvested, the diversion of forest biomass from traditional forest product markets to bioenergy, and the rates of afforestation and deforestation. Estimating the net effect of these changes on carbon stocks requires a model that integrates market demand and supply conditions with biophysical conditions that determine growth of forest biomass, losses via decomposition, carbon sequestration and fluxes due to harvests and land use change and incorporates the spatial variability in these effects across the U.S. The complexity of such a modeling approach can make it difficult to parameterize and validate, and thus ~~poses a significant challenge for use in any context. Extra effort will be needed to provide the public with thorough and requires a~~ sensitivity ~~analysis~~ analyses of parameters and model assumptions, and explicit recognition of model uncertainties in resulting BAF estimates~~. The lack of empirical data regarding many of these relationships and the resulting uncertainties~~ pose a significant challenge to use of this type of model in a ~~regulatory context.~~

Also, consistent with the SAB's 2012 recommendations, the EPA has now moved toward a "representative factor" approach that would include an assessment of the biogenic landscape attributes

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(type of feedstock, region where produced). The EPA initially considered calculating a BAF for an individual stationary facility; however, the data needs for a facility-specific approach are daunting if they are to be accurate (e.g., case-specific measurements and calculations of carbon stocks and chain-of-custody carbon accounting, integration of land use changes on a broader landscape level). EPA's use of a representative factor approach is an advance in its accounting methodology, although overly-broad feedstock categories may not reflect important extant or likely future variation in feedstock production or processing (e.g., roundwood in the Southeast, logging residues in the Pacific Northwest, and corn stover in the Corn Belt). The overall approach is a positive development, but caution is required to ensure such inclusiveness does not produce unintentionally negative outcomes, e.g. feedstocks with large net emissions to the atmosphere lumped together with those with more limited net emissions. The EPA should evaluate the "representativeness" of the factors and refine the approach over time with additional data.

As stated in the SAB's 2012 report, there are tradeoffs between ease of implementation (transaction costs), ~~precision~~ generalizability (getting it right at every location), accuracy (getting the overall stock change correct), and ~~policy~~regulatory effectiveness (ensuring that the ~~policy~~regulatory objectives are being met). The SAB continues to recognize the difficulty of undertaking the recommended anticipated future baseline approach, and practicality should be an important consideration in the agency's decision making. While the reference point baseline approach has significant limitations as noted in the SAB's 2012 report, these might be ~~overcome~~ mitigated if regular updating with empirical data to capture regional carbon stock changes (increases or decreases) were employed. All methods considered should be subject to an evaluation of the costs of implementation and compliance and weighed against any increase in accuracy ~~and precision~~ that they might yield. Ultimately it is critical that there is a balance among these considerations~~between accuracy and minimization of implementation costs~~.

Commented [SA10]: was "precision" exactly the word use int he 2012 report for "getting it right at every location"? If so, my suggested rewording cannot be used, but that is sure not the definition of "precision".

Recommendation

- The EPA should identify and evaluate its criteria for choosing a model and its underlying assumptions with regards to how these criteria and assumptions affect the robustness and reliability of calculated representative BAFs. In addition, the EPA should periodically update and validate the selected model to incorporate the latest scientific knowledge while ensuring that the model outputs are consistent with empirical observations (e.g. shifts in measured carbon stocks as determined the Forest Inventory Analysis program). Any model chosen should be subject to sensitivity analysis to evaluate its efficacy under different conditions and to identify data needs and prioritize future research.

3.3. Alternative Fate Approach for Waste-Derived Feedstocks

In 2012, the SAB recommended that the EPA consider alternative fates (i.e., if not used as fuel for electricity generation or process heat) of waste-derived feedstocks diverted from the waste stream, e.g., whether these feedstocks might decompose over a long period of time, whether they would be deposited in anaerobic landfills, whether they would be diverted from recycling and reuse, etc. In the 2014 Framework, the EPA has conducted extensive alternative fate calculations; however, the agency drew a narrow boundary around point source emissions and neglected other significant considerations that affect the GHG footprint of alternative municipal solid waste management scenarios. Specifically, the EPA neglected to quantify a potential alternative fate of municipal solid waste through landfill-derived

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methane combustion. Under the Clean Air Act New Source Performance Standards, the EPA requires landfills above a certain size to, at a minimum, collect and control landfill gas (e.g., through flaring or use). As such, a baseline of direct venting is misleading, although almost all these facilities are likely to produce large emissions of methane, even when in compliance with current regulations (Lamb et al 2016: [HYPERLINK "file:///C:\\Users\\tcarpent\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\9EYAZ1S8\\www.epa.gov\\lmop\\basic-information-about-landfill-gas"]). The relative rankings of BAFs across waste treatment options assessed in the 2014 Framework might change considerably if a more complete accounting were undertaken (e.g., energy recovery from landfill-derived methane and combustion of waste, and carbon storage associated with landfills.)

3.4. Temporal and ~~spatial~~ Spatial considerations in Biogenic Assessment Factor Calculations

The goal of the EPA Framework reviewed is to account for effects of biomass feedstocks used for energy generation at stationary facilities on terrestrial carbon stocks. BAFs are a carbon accounting method based on expected future changes in carbon stocks (measured in tons of carbon). They are designed to assess the net contribution of CO_2 from a stationary facility that uses biomass feedstocks, due to shifts of terrestrial carbon to and from the atmosphere over a specified period of time. The time scale selected will vary depending on ~~policy~~regulatory-defined objectives (e.g., reduction of GHG emissions in 2050 or 2100, or minimizing global temperature change resulting from greenhouse gas emissions). Over the selected time period, all greenhouse gas impacts (not just CO_2) – both positive and negative – should be accounted for (as completely as is feasible).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for the application EPA defines (stationary facility for energy production). A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks. As noted by Cintas et al. (2016), "assessment at the landscape scale integrates the effects of all changes in the forest management and harvesting regime that take place in response to – experienced or anticipated – bioenergy demand. Taken together, these changes may have a positive, negative or neutral influence on the development of forest carbon balances." Landscape level accounting of effects of forest-based feedstocks on carbon stocks can result in a net gain or loss of carbon stocks in the near to medium term; a carbon debt could be followed by a carbon dividend or the other way around.

BAFs are a carbon accounting tool for assessing CO_2 emissions from facilities that consume biomass feedstocks for production of energy and are not life cycle assessments of net greenhouse gas emissions or their climate change effects. The distinction is that not all indirect systemic effects are considered in the BAF, nor are all GHG effects included. We also underscore our caution that the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, ~~policy~~regulatory efforts, market forces, or natural causes. If such monitoring demonstrates

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changes that are not included in the model used to develop the BAF, the BAF should be updated to align with the empirical data.

Recommendation

- Stationary facilities require a continuous supply of feedstock, thus a landscape approach is appropriate and likely most reliable ~~required~~ for accounting for the impacts of feedstock demand on carbon stocks.

RESPONSES TO EPA'S CHARGE QUESTIONS

3.5. Temporal/~~spatial~~ Spatial Scale for Biogenic Accounting

Charge Question 1: What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

There are several key factors that impact the dynamic nature of the BAF for a specific feedstock and region. The first is that the increased demand for biomass feedstocks in a region could potentially be met by a variety of sources obtained from the agricultural and forestry sectors, including annual and perennial agricultural crops, short rotation woody biomass and pulpwood, and crop and forest residues. Any increase in demand might involve using a larger proportion of an existing resource or diversion from non-energy products and landfills, converting land from other uses to growing biomass feedstocks, changing use of existing feedstocks, utilization of residues that would otherwise decay over some period of time. The effect of increased demand for biomass feedstocks on carbon stocks will depend on the mix of these feedstocks demanded and the scale of demand for these feedstocks.

Second, different biomass sources have different effects on carbon stocks over different timeframes. The plant systems, e.g. forests, agronomic systems, producing feedstocks differ in their rate of growth/regrowth, yield, potential to sequester carbon in biomass and soils, decay rates after harvest, and the type of land-use change that accompanies their production. These effects continue after the feedstock has been consumed by a stationary facility. We therefore recommend computing a cumulative BAF over the relevant time horizon. This cumulative BAF would be based on the difference in carbon stocks between a scenario without change (either computed using a reference point or anticipated baseline) and the increased biomass feedstock demand scenario and would vary with the time horizon selected by the objective in the relevant ~~policy~~regulations.

Key principles for calculating changes in the net carbon stocks should include: (1) the positive and negative impacts of demand for biomass over time, (2) a system-wide (landscape and economy) approach to account for direct and indirect effects, and (3) consistency across each region. Selecting different time horizons for different feedstocks being used to meet the same ~~policy~~regulatory objective would be inappropriate as it would yield inconsistent effects.

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Determining the scale of appropriate regions for calculating BAFs will require balancing similarity in the biophysical characteristics, similar growing conditions (growing season length, vegetation type) and economic factors, biomass demand, with ensuring that the edge to volume ratios of the regions are small enough to ensure minimizing incentives to manipulate the movement of biomass feedstocks among regions due to differing BAFs.

To fully account for all positive and negative terrestrial effects over time, we recommend using the "emissions horizon" ~~as described by the 2014 Framework applied~~that is determined to be relevant by the ~~to a~~ specific ~~policy~~regulatory ~~objective~~BAF-mandating regulation. As defined by the EPA, this "emissions horizon is the period of time during which the carbon fluxes resulting from actions taking place today actually occur …" (U.S. EPA 2014). If the objective for a given BAF is to have an effect on greenhouse gas emissions by a certain date, then the impacts aggregated by that date are the relevant metric to assess meeting the objective, and that date is the appropriate time horizon to end the BAF calculation. Accordingly, there is no single time horizon that will effectively address all policies or feedstocks since feedstock net effects are time-dependent and desired objectives for ~~policy~~regulatory changes target different time horizons. The SAB does not support a single time horizon as appropriate for ~~determining~~ estimating BAFs, because the computed values can vary significantly over differing time horizons and different objectives will be met over different time horizons.

The Panel suggested that the time horizon should be the length of time it would take for the effect of increased demand for biogenic feedstock on the carbon cycle to reach a steady-state. This occurs when the difference in carbon stocks between the increased biomass feedstock demand scenario and the business-as-usual scenario is no longer changing or when the difference is approaching an asymptote. This could result in a very long time horizon being selected for the BAF calculation, potentially hundreds of years if all feedstocks across all regions were to be included. The selection of such a time horizon would mean that for ~~policy~~regulatory objectives with shorter time horizons (e.g., meeting a 2050 emissions target), the accounting would not align with relevant effects of biomass feedstock use at stationary sources on the ~~policy~~regulatory objective. Whether it would be appropriate to use a model that can estimate effects over a much longer time horizon to estimate a BAF with a shorter time horizon will depend on whether that model simulates the relevant nearer-term interactions with sufficient detail to produce reasonable estimates of impacts at nearer term (interim) points in time as well as over the longer horizon.

Commented [SA11]: the point of adding this sentence is to make it clear that this discussion about time horizons is about the calculation of the BAF and not about the model that can be used. One of my major concerns on my first review of this document was that the section seemed to be about model horizons, not the time period over wheih a calculation of BAF is made. I will be mollified on my concern if we can add this one sentence.

Several factors determine the difference in carbon stocks between the business-as-usual scenario and the increased biomass feedstock demand scenario. A major factor is the "speed" with which carbon stocks respond after harvest; this can be influenced by several factors: the speed with which a feedstock regrows and can be harvested again, the mix of feedstocks produced, and the rate at which soil carbon stocks change. Thus, the mix of feedstocks used can influence the shape of the curve and when it reaches equilibrium.

Previous studies have shown that estimates of the effects of biomass harvest on carbon stocks depend on the spatial scale of consideration (stand level or landscape level), the initial conditions of carbon stock on the land (e.g., managed forestland, old growth forestland, or agricultural land), the management practices used, and the time horizon over which effects are measured (Walker et al., 2010; Jonker et al., 2014; Mitchell et al., 2012; Galik and Abt, 2012; Ter-Mikaelian et al., 2015). Harvest of an existing forest stand for use as a feedstock results in an immediate reduction of carbon on the site; the amount of

carbon lost at the stand level is directly related to the intensity of the disturbance. At a stand level, harvest followed by regrowth (most US forests regenerate without intervention/planting) usually results in a cycle of loss followed by gain. The amount of carbon regained on the site can vary: in some cases, all is regained, in others only part is regained, and in others, more can be gained than is released.

Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed asynchronously; the order in which losses and gains occur becomes meaningless at the landscape level because both simultaneously occur. Thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs for biomass feedstocks used at stationary sources. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the business-as-usual scenario, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.

Biomass, particularly from forest sources, is also used for producing non-energy products. The demand for biomass feedstocks for energy generation can lead to a diversion of biomass from those products and lead to an immediate reduction in carbon stocks in products. It is also possible that anticipation of future demand for biomass feedstocks by stationary facilities could lead to land conversion, reforestation and retention, or accumulation of carbon stocks in a growing forest. In general terms, the amount of either net loss or net gain of carbon on the landscape is influenced by changes in many factors including those influencing net primary production and removals, and the net effect can be expected to vary over time.

When agricultural feedstocks ~~that~~ are harvested annually from land under continuous production, the time lag between harvest, CO_2 emissions from conversion to energy, and regrowth on land is likely to be close to one year, and the harvested carbon will be fully regained, with no net impact on above-ground carbon stocks. The production of these feedstocks may directly affect carbon stocks below-ground by increasing or decreasing soil carbon stocks relative to the use of the land in the business-as-usual scenario. The demand for biomass feedstocks can also affect carbon stocks by leading to a change in the use of land which could either release carbon stored in the land (for example if permanent grasslands are converted to annual agricultural production) or accumulate carbon on the land (for example through reforestation as annual cropland is converted back to forests).

Recommendation

- The estimate of direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no ~~single~~ optimal time horizon for evaluating these impacts, and it may be primarily determined by the regulation mandating use of BAF.

Charge Question 1(a): Should the temporal scale for computing biogenic assessment factors vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or

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other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.

Charge Question 1(a)(i). If temporal scales for computing biogenic assessment factors vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?

Charge Question 1(a)(ii). Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?

Charge Question 1(a)(iii). Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default biogenic assessment factors versus crafting policy specific biogenic assessment factors?

Charge Question 1(b). Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?

The responses to questions 1(a), 1(a)(i), 1(a)(ii), 1(a)(iii), and 1(b) are combined because these questions all relate to goals or criteria that may affect choices of differing temporal scales for calculating BAFs.

Question 1a asks specifically if the temporal scale for computing ~~Biogenic Assessment Factors~~BAFs should vary by regulatory policy. As noted in the overall response to Charge Question 1 (above), the SAB concludes that the BAF computation should be informed by the ~~policy~~regulatory objectives, ~~particularly~~ including with respect to time.

If there are ~~multiple~~ different objectives in multiple ~~policies~~ regulations mandating use of BAFs (as discussed in charge question 1(a)(i)), there are no overriding scientific principles that can be applied *a priori* to guide alignment ~~among~~ in the tools to be used for calculating BAFs for ~~these multiple~~different objectives.

One could advocate for a host of approaches to selecting a time horizon for evaluation; all would be plausible but not inherently aligned with the objective of the ~~policy~~ regulations being promulgated. At the extremes one could consider only the carbon accounting over the year in which the biomass was combusted; such an approach would mean that almost all feedstocks would be assigned a BAF close to one, representing no net benefit to reducing atmospheric carbon dioxide concentrations. Conversely one could only consider net impacts on the carbon cycle over several hundred years, which would mean for most feedstocks the BAF would be close to zero (assuming steady demand and unchanged rotation lengths thus allowing stocks to come into equilibrium), indicating all biogenic emissions being net beneficial to the atmosphere. Neither of these approaches would align with the most likely objectives of ~~a biogenic accounting framework~~BAFs; however, neither is inherently correct or incorrect.

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The time horizon for consideration of carbon stock changes should be chosen based on the specific objective of a regulation, once it is identified (e.g., minimizing net greenhouse gas emissions over a specified period or temperature increase by a certain date~~), which would be aligned with the policyregulatory goals~~). The SAB makes no assertion regarding the appropriate ~~policy~~regulatory use of the BAF and thus supports no specific time horizon selected independent of a ~~policy~~regulatory ~~objective~~requirement.

Charge Question 1(c). Should calculation of the biogenic assessment factor include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?

Accumulating all effects of the use of a biogenic feedstock over a time horizon is preferred to a marginal or instantaneous ("per period") BAF. (For the purposes of answering this question, the SAB interprets "marginal" to mean "annual" or "per period" so as to distinguish it from the meaning of "marginal" that typically refers to the last unit of emissions or the additional effect of the last unit of biomass.)

As described in the overall response to Charge Question 1 (above), the SAB recommends a cumulative carbon accounting metric; however, there are alternative ways to calculate cumulative BAFs. EPA's cumulative BAF (called BAF_T in the 2014 Framework) applied to stocks is one option, reflecting the carbon stocks at the end of the time horizon—specifically, changes in carbon stocks by time, T. One can also calculate a cumulative BAF that is based on the accumulation of annual differences in carbon *stocks* on the land *over the time horizon until equilibrium is reached*, here called $BAF_{\Sigma T}$. By accumulating annual differences across the projection period, this alternative cumulative BAF metric attempts to incorporate "residence time" in the sense that it is a proxy for the length of time carbon stays in the atmosphere until it is modified by changing stocks of carbon on the land. While intended to generate a single BAF term at the end of the selected time horizon, either computation can be evaluated at any time of interest. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach, i.e., the difference in carbon stocks *at the end of the selected time horizon.*

The choice of an appropriate cumulative BAF should be informed by a scientific assessment of the dynamics of additions to atmospheric carbon stocks as well as the complexities and uncertainties of these determinations, ensuring the accounting is accurate and verifiable. Both cumulative BAFs attempt to capture net changes in biogenic carbon stocks. A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated and are still subject to mass balance.

With either approach to evaluating BAFs, caution is advised with projections into the future. A BAF is inherently based on some type of modeling that employs assumptions about the relationship of variables in the future based on current observations. These assumptions may not be robust in the future. Each BAF will need to be assessed periodically to see if changing conditions warrant a revision (Bucholz et al. 2014).

Carbon accounting for biogenic emissions can ~~either~~ be framed either using differences in carbon emissions to the atmosphere or using differences in carbon stocks on the land. Conservation of mass dictates that any carbon taken from the land (through increased harvests or other disturbances) will

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result, in the near-term, in equivalent increases of carbon in the atmosphere, followed by longer-run changes in ocean and land-based carbon. Thus, these approaches are compatible, but examining changes in stocks is operationally more direct and can be done periodically, rather than requiring continuous measurements to be accurate. However, both approaches should account for changes within the boundaries of the analysis, such as import and export of biogenic feedstocks and other associated products.

Long-Term Trends in Biogenic Assessment Factors

The Panel has suggested that cumulative BAFs might approach zero as T is reached. However, that is only true for $BAF_{\Delta t}$ and not the cumulative BAFs. Mathematically cumulative BAFs are hyperbolic functions once T is reached and have extremely long "tails", representing a period of net CO_2 emissions to the atmosphere.

An approach to determining a baseline that includes an historical time period could be used to periodically reset a reference baseline based on re-measuring carbon stocks on the landscape using data from existing inventory programs. Carbon stock measurements have been made for more than a half century in the US, offering a robust record of change. This approach could improve the accuracy of the baseline over time; however, as noted above, the preference for use of a reference or future anticipated baseline depends on the objective. Future changes in growth-to-harvest ratios could be used to inform the model assumptions and modify the BAF that would be applicable going forward. This could create long-term incentives for sustainable management of land resources. In any accounting framework that assumes future regeneration and regrowth, it is important to periodically test this assumption against actual data as they become available. If assumptions of future regeneration and regrowth are not supported by observations, adjustments need to be made to models that are used to determine BAFs.

Recommendations

- The SAB recommends formulating BAFs based on changes in carbon stocks (terrestrial pools such as live, dead, soil, products, material lost in transport and waste), rather than an emissions-based (flux-based) approach, because the former comports with conventional carbon accounting, has well-defined boundaries, and follows the conservation of mass.

- The SAB suggests consideration of two cumulative BAFs—that proposed by EPA and an alternative metric that takes into account the changes in terrestrial carbon stocks over time. The appropriate cumulative metric for calculating BAFs will depend on the understanding of the carbon system and climate response for which there is uncertainty.

Charge Question 1(d). What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions ex post), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is appropriate to periodically revise the modeling and the BAFs. The goal of such revisions would be to update underlying economic and biophysical assumptions and modeling trends in light of new data to reduce uncertainty and to increase accuracy of future projections.

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A retrospective comparison would compare model-projected behavior to newly available historical observations and estimates, such as regional feedstock demand, land-use changes (e.g., reforestation, management intensity, forest rotations characteristics and conversion of land to other land uses including dedicated energy crops), and forest carbon measurements and estimates (both level and composition). It would be important to re-examine parameters, functional forms, and other assumptions of the modeling approach as part of an *ex post* evaluation.

3.6. Scales of Biomass Use

Charge Question 2: What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?

Charge Question 2(a). Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
Charge Question 2(b). What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?

The responses to questions 2(a) and 2(b) are combined below because both questions relate to the size of the simulated change in demand for biomass feedstocks. The complexities are large and any predictions on scale of demand shock can only be done effectively in a ~~policy~~regulatory context as they are very challenging to define otherwise.

If the EPA's goal is to obtain a region-specific BAF for a feedstock, it will be necessary to project region-specific and feedstock-specific demand for biomass. Since the BAF for a feedstock could differ depending on the method of production (for example, the soil carbon implications of corn stover will depend on the type of tillage practice used and the amount of residue harvested), it will be appropriate to have the BAF for a feedstock in a region reflect the methods used to produce that feedstock. To the extent that BAFs depend on technology and emissions control regulations at a stationary facility in a region, they could also be defined in terms of specific technologies.

Charge Question 2(c). Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?

In the absence of a specific ~~policy~~regulatory to model, the SAB cannot offer general recommendations for a representative scale of demand shock.

Charge Question 2(d). Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?

Charge Question 2(e). For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a

change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).

The responses to questions 2(d) and 2(e) are combined because both questions relate to modeling biomass feedstocks in isolation or jointly.

In the absence of a mandate for use of specific feedstocks or incentives for specific types of bioenergy which might be prescribed in a ~~policy~~regulatory framework, and which would inform the feedstock-specific demand that should be modeled, a reasonable approach is to model the aggregate demand for feedstocks. This approach assumes facilities are constantly seeking their least-cost alternative. An aggregate demand could be imposed on the model and used to determine demand for different feedstocks in different regions. This would allocate demand across feedstocks as well as within each category to simulate a given target aggregate demand determined by the market's ability to draw from the least cost combination of feedstocks.

Charge Question 2(f). How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?

Default BAFs would likely vary by the scale of demand. In fact, a single set of default BAFs is unlikely to be robust across a wide range of scales of demand. The scale of demand is likely to influence the mix of feedstocks that is viable to produce because it can be expected to affect the market price of biomass. Low levels of demand for biomass may be met relatively easily by crop residues, forest residues and mill residues; high levels of demand could lead to dramatically increased harvests of forest biomass or production of dedicated energy crops. The BAF of a feedstock in a region can be expected to vary depending on whether there is a 1-million-ton increase in biomass demand or a 1-billion-ton increase in biomass demand.

In the absence of information about the scale of demand, BAFs could be determined for different threshold levels of aggregate demand for biomass feedstocks and consequent feedstock/region-specific demand.

Charge Question 2(g). Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?

While the methodological framework for different policies could be similar, we expect differences as follows: (1) BAFs that are tied to a particular regulatory ~~policy~~approach, versus a particular period of time, would be based on simulating the aggregate and feedstock-specific demand that is expected to emanate from that ~~policy~~regulation, while ~~policy~~regulatory neutral factors would be based on various exogenously specified quantities of demand for biomass and corresponding endogenously determined levels of feedstock specific demand, and (2) different policies may require different production and use practices, and thus result in different biogenic factors. Isolating the extent to which expected increase in demand for biomass and its consequences for CO_2 emissions can be attributed to a specific ~~policy~~regulation (when there are multiple policies inducing a shift to renewable energy) is likely to be

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complicated and challenging to convert into ~~policy~~regulatory-specific BAFs. It could also create unintentionally negative incentives for feedstock choice to comply with various policies.

Charge Question 2(h). What considerations could be useful when evaluating the performance of the demand shock choice ex post, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is likely that the observed feedstock demand in response to a specific ~~policy~~ regulation will differ from the forecast because the ~~policy~~regulation can be expected to increase demand for feedstocks with lower BAF and decrease demand for feedstocks with a high BAF. Since feedstock-specific demand and the feedstock BAFs are likely to be jointly determined, while the approach proposed above determines them sequentially, divergence between model simulated demand for feedstocks and observations is inevitable.

An evaluation using actual data would also allow revisions to the EPA's estimates of feedstock demand changes (as discussed in response to Question 1d) based on updated data. To improve the performance of the model for assessing BAFs retrospectively, quantities of biomass feedstock (by feedstock category) harvested could be updated with actual observations. New data should improve the estimate of the portion of total biomass demand that is attributable to stationary facilities. This information could be used to improve BAFs.

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REFERENCES

Bucholz, T., Prisley, S., Marland, G., Canham, C. and Sampson, N. (2014) Uncertainty in predicting GHG emissions from bioenergy. *Nature Climate Change* 4:1045

Cherubini, F., Guest, G. and Stromman, A. (2012). Application of Probability Distributions to the Modeling of Biogenic CO2 Fluxes in Lifecycle Assessment. *Global Change Biology Bioenergy* 1 - 15.

Cintas, Olivia, Göran, B., Cowie, A., Egnell, G., Holmstrom, H., Marland, G and Ågren, G. (2017). Carbon balances of bioenergy systems using biomass from forests managed with long rotations: bridging the gap between stand and landscape assessments. *Global Change Biology Bioenergy*. Retrieved from doi: 10.1111/gcbb.12425, 2017

Galik, C.S. and Abt. R.C. (2012). The effect of assessment scale and metric selection on the greenhouse gas benefits of woody biomass. *Biomass and Bioenergy* 44:1–7.

Galik, Christopher S, and Robert C. Abt. (2012). "The Effect of Assessment Scale and Metric Selection on the Greenhouse Gas Benefits of Woody Biomass." *Biomass and Bioenergy* 44 (September): 1–7. doi:http://dx.doi.org/10.1016/j.biombioe.2012.04.009.

IPCC (Intergovernmental Panel on Climate Change). (2007). *Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007.* Cambridge, United Kingdom and New York, NY. Retrieved from [HYPERLINK "http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf"].

Jonker, Jan G.G., Junginger, M. and Faaij, A. (2014). "Carbon Payback Period and Carbon Offset Parity Point of Wood Pellet Production in the South-Eastern United States." *Global Change Biology Bioenergy* 6 (4): 371–89. doi:10.1111/gcbb.12056.

Lamb, B.K., Cambaliza, M.O.L., Davis K.J., Edburg, S.L., Ferrara, T.W., Floerchinger, C., Heimburger, A.M.F., Herndon, S., Lauvaux, T., Lavoie, T., Lyon, D.R., Miles, N., Prasad, K.R., Richardson, S., Roscioli, J.R., Salmon, O.E., Shepson, P.B., Stirm, B.H. and Whetstone, J. (2016) Direct and Indirect Measurements and Modeling of Methane Emissions in Indianapolis, Indiana *Environmental Science and Technology*. 50: 8910-8917

Mitchell, Stephen R., Harmon, M.E. and O'Connell, K.E.B. (2012). "Carbon Debt and Carbon Sequestration Parity in Forest Bioenergy Production." *GCB Bioenergy* 4 (6): 818–27. doi:10.1111/j.1757-1707.2012.01173.x.

ED_004741_00008627-00032

National Council for Air and Stream Improvement. (2015). Comment to the Biogenic Carbon Emissions Panel of the EPA Science Advisory Board. August 5, 2015. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/254A0104C4745E5785257E98006493E4/$File/NCASI+comments+for+Aug.+6,+2015.pdf"]

Ocko, I.B., Hamburg, S.P., Jacob, D.J., Keith, D.W., Keohane, N.O., Oppenheimer, M., Roy-Mayhew, J.D., Schrag, D. P. and Pacala, S.W. (2017) Two-valued Global Warming Potential Effectively Captures Long- and Short-term Climate Forcing. *Science.* 356:492-493

Shoemaker, J.K., Schrag, D.P., Molina, M.J. and Ramanathan, V. (2013). "What Role for short-Lived Climate Pollutants in Mitigation Policy?" *Science* 342: 1323-1324.

Ter-Mikaelian, Michael T., Colombo, S.J. and Chen, J. (2015). "The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions? A Review of Common Misconceptions about Forest Carbon Accounting. " *Journal of Forestry* 113 (1): 57–68.

U.S. EPA (Environmental Protection Agency). (2011). *Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources.* Office of Atmospheric Programs. Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886/$File/Biogenic_CO2_Accounting_Framework_Report_LATEST.pdf.

U.S. EPA (Environmental Protection Agency). (2014). *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources.* Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf//LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252/$File/Framework-for-Assessing-Biogenic-CO2-Emissions+(Nov+2014).pdf.

U.S. EPA (Environmental Protection Agency). (2015). *Response to the SAB Panel Peer Review Advisory*. Retrieved from SAB Biogenic Carbon Emissions Panel Meeting Webpage. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/SABPRODUCT.nsf/5295DAC6053510F285257DFD0075C181/$File/OAR+Response+to+SAB's+2012+Advice.pdf"].

U.S. EPA SAB (U.S. EPA Science Advisory Board). (2012). *SAB Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources*. Retrieved from SAB website : [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf"].

Walker, Thomas, Cardellichio, P., Colnes, A., Gunn, J., Kittler, B. Perschel, B., Recchia,C. and Saah, D. (2010). "Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources." Manomet Center for Conservation Sciences, no. June: 182. doi:NCI-2010-03.

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APPENDIX A: CHARGE TO THE SAB

February 25, 2015

MEMORANDUM

To: **Holly Stallworth, Designated Federal Official**
Science Advisory Board Staff Office

From: Paul Gunning, Director
Climate Change Division

Subject: **Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources and Charge Questions for SAB peer review**

The purpose of this memorandum is to transmit the revised *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources,* related documentation and charge questions for consideration by the Science Advisory Board (SAB) during your upcoming peer review.

In January 2011, the U.S. Environmental Protection Agency (EPA) announced a series of steps it would take to address biogenic CO_2 emissions from stationary sources. EPA committed to conduct a detailed examination of the science and technical issues related to assessing biogenic CO_2 emissions from stationary sources and to develop a framework for evaluating those emissions. The draft study was released in September 2011 and subsequently peer reviewed by the SAB Ad-Hoc Panel on Biogenic Carbon Emissions (SAB Panel). The final peer review report was published September 2012.

To continue advancing the agency's technical understanding of the role that biomass use can play in reducing overall greenhouse gas emissions, the EPA released a second draft of the technical report, *Framework for Assessing Biogenic Carbon Dioxide for Stationary Sources*, in November 2014. This revised report presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions. The revised report takes into account the SAB Panel's peer review recommendations on the draft 2011 Framework as well as the latest information and input from the scientific community and other stakeholders.

The revised framework addressed many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis, including an alternative fate approach for waste-derived feedstocks and certain industrial processing products and byproducts; an evaluation of tradeoffs from using different temporal scales; an improved representation of the framework equation; and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales.

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We ask the SAB to review and offer recommendations on specific technical elements of the revised framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions, as identified in the charge accompanying this memo. We look forward to the SAB's review.

Please contact me if you have any questions about the attached study and charge.

Attachments:

1) *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*
2) Technical Appendices
3) Response to the 2011 SAB Panel Peer Review Advisory

Peer Review Charge on the Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

To improve the quality, utility, and scientific integrity of the Framework, EPA is providing this study, *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (November 2014) and related materials to the Science Advisory Board (SAB). The revised report takes into account the SAB Biogenic Carbon Emissions Panel's ("SAB Panel") peer review recommendations[2] on the draft 2011 Framework[3] as well as the latest information and input from the scientific community and other stakeholders. The "Response to SAB" document included in the materials provided for this review discusses and responds to the SAB Panel key points and recommendations, serving as a guide to how the revised framework incorporates their recommendations. This charge narrowly focuses on a few specific remaining questions that were not explicitly addressed in the initial SAB Panel peer review report.

The revised 2014 framework report identifies key scientific and technical factors associated with assessing biogenic CO_2 emissions from stationary sources using biogenic feedstocks, taking into account information about the carbon cycle. It also presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions.

The revised framework and the technical appendices address many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis (Appendices J-L); an alternative fate approach for waste-derived feedstocks (Appendix N); and certain industrial processing products and byproducts (Appendix D Addendum); an evaluation of tradeoffs from using different temporal scales (Appendix B); an improved representation of the framework equation (Appendix F); and illustrative case studies demonstrating how the framework equation can be applied, using region-

[2] The final peer review report from the SAB Panel on the draft 2011 framework was published on September 28, 2012 (Swackhamer and Khanna, 2011). Information about the SAB peer review process for the September 2011 draft framework is available at [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886"].

[3] The 2011 *Draft Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources* is available at [HYPERLINK "http://www.epa.gov/climatechange/ghgemissions/biogenic-emissions.html"].

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feedstock combinations to generate regional defaults per different baseline approaches and temporal scales (Appendices H-N).

As explained in the revised framework introduction and accompanying SAB response document, the revised framework maintains the policy neutral approach from the 2011 draft Framework. It is a technical document that does not set regulatory policy nor does it provide a detailed discussion of specific policy and implementation options. Ultimately, the framework provides a methodological approach for considering, and a technical tool (the framework equation) for assessing, the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources. The revised framework details technical elements that should be considered as appropriate per specific policy applications or biogenic carbon-based feedstock assessments. Therefore, this charge excludes policy and regulatory recommendations or legal interpretation of the Clean Air Act's provisions related to stationary sources.

The revised report does not provide any final values or determinations: it offers indications of different biogenic feedstock production effects per research and analyses conducted, including illustrative example results per specific case study parameters. As discussed by the previous SAB Panel, this report also finds that biophysical and market differences between feedstocks may necessitate different technical approaches. Even using a future anticipated baseline approach, forest- and agriculture-derived feedstock characteristics, and thus analyses and results, may vary per region and per feedstock, and may be influenced by land use change effects. Illustrative analyses conducted for specific waste-derived feedstock case studies using a counterfactual anticipated baseline, as recommended by the SAB Panel, yielded minimal or negative net emissions effects.

This charge focuses on questions that remain regarding whether there are more definitive technical determinations appropriate for parameterizing key elements of the revised framework, regardless of application to a specific policy or program. Specifically, we ask that the SAB Panel examine and offer recommendations on future anticipated baseline specification issues in the context of assessing the extent to which the production, processing, and use of forest- and agriculture-derived biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions – such as appropriate temporal scales and the scale of biogenic feedstock usage (model perturbations or 'shocks') for analyzing future potential bioenergy production changes.

Technical approaches, merits and challenges with applying a future anticipated baseline

Establishing a baseline creates a point of comparison necessary for evaluating changes to a system.[4] Baseline specification can vary in terms of what entity or groups of entities are being analyzed (e.g., industries, economic sectors), temporal and spatial scales, geographic resolution, and, depending on context, environmental issues/attributes (EPA, 2010).[5] The choice of baseline approach can also depend on the question being asked and the goal of the analysis at hand. For example, some GHG analysis may

[4] Definitions for baseline vary, including "the reference for measurable quantities from which an alternative outcome can be measured" (IPCC AR4 WGIII, 2007) or "the baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines" (IPCC AR4 WGII, 2007).

[5] Guidelines for Preparing Economics Analyses (NCEE), Chapter 5: [HYPERLINK "http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-05.pdf/$file/EE-0568-05.pdf"]

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require a baseline against which historic changes of landscape carbon stocks can be measured. Other applications may necessitate a baseline against which the estimated GHG emissions and sequestration associated with potential future changes in related commodity markets and policy arenas. Analyses of the estimated GHG emissions and sequestration effects from changes in biomass use have used different baseline approaches, as well as a wide range of different temporal scales and alternative scenario parameters (Sohngen and Sedjo, 2000; Fargione, 2008; UNFCCC, 2009; Walker et al., 2010; Cherubini et al, 2011; Galik and Abt, 2012; Latta et al., 2013; Walker et al., 2013; AEO, 2014; U.S. EPA, 2014; Miner et al., 2014).

The draft 2011 framework had discussed three different potential baseline approaches – reference point, future anticipated and comparative – and used the reference point baseline in its hypothetical case study applications of the Framework. The SAB Panel in its review stated that "the choice of a fixed reference point may be the simplest to execute, but it does not actually address the question of the extent to which forest stocks would have been growing/declining over time in the absence of a particular bioenergy facility" (SAB Advisory, p. 29). The SAB Panel expressed concern that the reference point baseline does not address the important question of additionality, or what would have been the trajectory of biogenic CO_2 stocks and fluxes in the absence of an activity or activities using biogenic feedstocks for energy, especially in the context of forest-derived feedstocks.[6] "Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach" (SAB Letter, p. 2).

Through public comments to the SAB Panel during the 2011-2012 SAB peer review process, various stakeholders expressed divergent perspectives on the appropriate baseline for the draft 2011 framework report.[7] The revised 2014 framework retains the reference point baseline and adds the anticipated baseline in order to retain adaptability for potential applications, and discusses both approaches at length in the revised report and several technical appendices. However, as the SAB Panel was clear in its previous review of the reference point baseline, EPA has no outstanding technical questions for the SAB Panel on that baseline approach. This charge focuses specifically on remaining technical questions that EPA has on the future anticipated baseline approach.

Part 1 – Future anticipated baseline approach and temporal scale

It is important to consider possible treatments of time and the implications of these treatments in developing strategies for long-term and short-term emissions assessment, because the choice of

[6] The difference in net atmospheric CO_2 emissions contributions with and without changes in biogenic feedstock use is known as additionality (Murray et al., 2007). Additionality can be determined by assessing the difference in potential net atmospheric CO_2 emissions of a specific level of biogenic feedstock use over a certain period of time (in many cases the business-as-usual [BAU] baseline) versus the net atmospheric CO_2 emissions contributions that would have occurred over the same time period with a different level of biogenic feedstock use (counterfactual scenario), holding other factors and assumptions consistent between scenarios.

[7] The American Forest and Paper Association (AF&PA) supported the reference point baseline (e.g., comments submitted October 2011, March 2012) applied historically (January 2012, March 2012). The National Alliance of Forest Owners (NAFO) stated if certain feedstocks weren't categorically excluded, then the historical reference point baseline should be used (e.g., March 2012, August 2012). The U.S. Department of Agriculture stated preference for a historic baseline approach (May 2012). The Environmental Defense Fund (EDF) (January 2012, May 2012) and NCASI (October 2011, March 2012) both supported the retrospective reference point approach, though also both offered recommendations if an anticipated baseline approach was included (EDF for future anticipated and NCASI for counterfactual). Others, such as Green Power Institute (March 2012), the National Resource Defense Council (NRDC, August 2012), Becker et al. (August 2012), Biomass Energy Resource Center et al. (February 2012), and a group scientists letter to EPA (June 2014) all support some form of the anticipated baseline approach (future anticipated and/or counterfactual).

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treatment may have significant impacts on the resultof an assessment framework application. For the intended use of the revised Framework – assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions – there are different elements of time to consider when using a future anticipated baseline approach. These elements can include:

- Emissions horizons, assessment or policy horizons, and reporting periods (i.e., fluxes related to feedstock production may occur over many years to decades, whereas reporting may be the current year and policies may cover only a few years or decades), and
- Differences in temporal characteristics of different feedstocks (i.e., annual crops, short rotation energy crops, and longer rotation forestry systems).
- Changes in biophysical and economic conditions over time may affect or differ from those in future anticipated baseline and scenario estimates.

The SAB Panel in its previous peer review noted that "this is a complicated subject because there are many different time scales that are important for the issues associated with biogenic carbon emissions" (Advisory, page 13). They discussed multiple temporal scales associated with mixing of carbon throughout the different reservoirs on the Earth's surface at the global scale (Advisory, page 13) and climate responses to CO_2 and other greenhouse gases (Advisory, page 15), implications of temporal scales greater and shorter than 100 years, and those related to the growth cycles of different feedstock types (Advisory, page 15). The SAB Panel specifically highlighted considerations for using a 100-year or longer temporal scale for evaluating climate impacts and radiative forcing[8] as well as decay rates and carbon storage in forest ecosystems in the main text as well as in Appendices B-D. However, in its recommendations, including those for developing default BAFs per region, the SAB Panel did not offer recommendations per what temporal scale to use in the specific context of the Framework for its intended use and scope. Instead, the SAB Panel stated that "there is no scientifically correct answer when choosing a time horizon, although the *Framework* should be clear about what time horizon it uses, and what that choice means in terms of valuing long term versus shorter term climate impacts (Advisory, page 15) and recommended that a revised framework "incorporate various time scales and consider the tradeoffs in choosing between different time scales" (Advisory, page 43).

Multiple stakeholders have also weighed in on temporal scales, some with specific recommendations on what temporal scale should/could be used for framework assessments, others with no specific recommendations but emphasizing the importance of time. In various comments submitted during the 2011-2012 SAB process, NAFO supported a 100-year timeframe (March 2012). The National Council for Air and Stream Improvement (NCASI) in October 2011 comments suggested "the need for considerable flexibility in setting the temporal scales for determining the stability of forest carbon

[8] EPA acknowledges that the long-term climate impacts of shifting from fossil fuel to biogenic energy sources is an important topic for climate change mitigation policy and also recognizes the extensive work being conducted by EPA and throughout the research community on this question. However, EPA's focus here is on a narrower, more targeted goal of developing tools to assess the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic feedstocks at stationary sources. This more narrowly defined assessment is anticipated to be a better fit for the types of program and policy applications in which this framework may potentially be applied.

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stocks. There are a range of circumstances that can cause transient trends in carbon stocks that can obscure the more relevant long-term picture."

Other groups, such as The Wilderness Society (TWS), NRDC, EDF and others, submitted comments supporting consideration of shorter temporal scales. In its comments and example calculations, TWS (in October 2011 comments) implied support for shorter temporal scales, and stated in later comments that the SAB "text appears biased toward ignoring effects that occur within a 100-year period" (May 2012). NRDC (August 2014) implied support for shorter temporal scales: "even if near-term carbon emissions increases are eventually 'made up' by regrowth over the very long term, the carbon emission from these types of biomass actually exceed those from fossil fuels for decades. This puts use of these types of biomass fuels in conflict with the urgent need for near-term carbon emissions reductions. The time profile of the carbon emission from biogenic fuel sources matters because it is critical to limit near-term global GHG emissions." This perspective was similar to that shared by Becker et al. in their August 2012 comments. EDF (January 2012) suggested a very short temporal scale (in the context of supporting a retrospective reference baseline). Others, such as the Biotechnology Industry Organization (October 2011) simply asked for "clarification on the methodology used to identify the time scale of carbon cycles."

Per the various recommendations above, the revised framework report and the technical appendices include a more detailed discussion of intertemporal tradeoffs inherent in various options for treating emissions over time in the context of assessing biogenic CO_2 emissions from stationary sources. Specifically, the revised report has: a section on key temporal scale considerations (pages 33-38); an appendix dedicated to temporal scale issues (Appendix B), which includes further discussion of temporal scales in the context of future anticipated baselines and decay rates for feedstocks that would have otherwise decayed if not used for energy, and; an appendix describing the background of and modeling considerations for constructing an anticipated baseline approach (Appendix J). Also, illustrative calculations using the future anticipated baseline estimates use future simulations and thereby explicitly incorporate temporal patterns of different feedstocks (e.g., feedstock growth rates, decay rates) into the analysis and shows how results can vary per temporal scale used (as seen in Appendices K and L). The revised framework does not recommend specific temporal scales for framework applications, but rather identifies different elements of and considerations concerning time to provide insights into the potential implications of using different temporal scales.

EPA seeks guidance on the following issues regarding appropriate temporal scales for assessing biogenic CO_2 emissions using a future anticipated baseline, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the previous SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of temporal scale both within and outside of a specific policy context.

Part 1 – Future anticipated baseline approach and temporal scale

1. What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of

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biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

a. Should the temporal scale for computing BAFs vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.
    i. If temporal scales for computing BAFs vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?
    ii. Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?
    iii. Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default BAFs versus crafting policy specific BAFs?
b. Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?
c. Should calculation of the BAF include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?
d. What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions *ex post*), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

Part 2 – Scales of biomass use when applying future anticipated baseline approach

EPA seeks guidance on technical considerations concerning how to select model perturbations ('shocks') for future anticipated baseline simulations estimating the net atmospheric contribution of biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework

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could be also be used in specific policy contexts, the questions below relate to the choice of model shocks both within and outside of a specific policy context.

2. What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?
   a. Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
   b. What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?
   c. Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?
   d. Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?
   e. For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).
   f. How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?
   g. Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?
   h. What considerations could be useful when evaluating the performance of the demand shock choice *ex post*, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward

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APPENDIX B: MEMBERS OF THE BIOGENIC CARBON EMISSIONS PANEL

CHAIR

Dr. Madhu Khanna, ACES Distinguished Professor in Environmental Economics, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Urbana, IL

PANEL MEMBERS

Dr. Robert Abt, Professor of Forestry, Department of Forestry and Environmental Resources, College of Natural Resources, North Carolina State University, Raleigh, NC

Dr. Morton Barlaz, Professor, Civil, Construction, and Environmental Engineering, Engineering, North Carolina State University, Raleigh, NC

Dr. Marilyn Buford, National Program Leader, Silviculture Research, Research & Development, USDA Forest Service, Washington, DC

Dr. Mark Harmon, Professor and Richardson Chair, College of Forestry, Oregon State University, Corvallis, OR

Dr. Jason Hill, Associate Professor, Bioproducts and Biosystems Engineering, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota, St. Paul, MN

Dr. John Reilly, Senior Lecturer and Co-Director, Joint Program on the Science and Policy of Global Change, Center for Environmental Policy Research, E19-439L, Massachusetts Institute of Technology, Cambridge, MA

Dr. Charles Rice, Distinguished Professor, Department of Agronomy, Soil Microbiology, Kansas State University, Manhattan, KS

Dr. Steven Rose, Senior Research Economist, Energy and Environmental Analysis Research Group, Electric Power Research Institute, Palo Alto, CA

Dr. Daniel Schrag, Professor of Earth and Planetary Sciences, Harvard University, Cambridge, MA

Dr. Roger Sedjo, Senior Fellow and Director of the Center for Forest Economics and Policy Program, Resources for the Future, Washington, DC

Dr. Ken Skog, Supervisory Research Forester (retired), Economics and Statistics Research, Forest Products Laboratory, USDA Forest Service, Madison, WI

Dr. Tristram West, Ecosystem Scientist, Joint Global Change Research Institute, University of Maryland, College Park, MD

Dr. Peter Woodbury, Senior Research Associate, Department of Crop and Soil Sciences, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, U.S.A.

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Dr. Holly Stallworth, Designated Federal Officer, U.S. Environmental Protection Agency, Washington, DC

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DATE

EPA-SAB-19-xxx

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Subject: SAB review of *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014)

Dear Acting Administrator Wheeler:

The EPA Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014) ("2014 Framework"). The 2014 Framework considers the scientific and technical issues associated with accounting for emissions of carbon dioxide (CO_2) from biogenic feedstocks used at stationary sources.

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor, for CO_2 emissions associated with the combustion of biogenic feedstocks at stationary facilities by accounting for the biological carbon cycle effects associated with growth, harvest, and processing of these feedstocks. The BAF is an accounting term developed by EPA to adjust stack emissions to reflect a feedstock's *net* carbon emissions after accounting for subsequent sequestration of carbon in regrown biomass or soil, and after considering emissions that might have occurred with an alternate fate had the biomass not been used for fuel.

The SAB notes that EPA's 2012 Framework may be used for multiple climate objectives and resulting regulations, and therefore it must consider a wide range of potential time and spatial scales, all relevant GHGs, and policy goals (i.e., total emissions versus temperature, etc.) in order to calculate specific BAFs applicable to that objective, making it difficult for the SAB to address many of the charge questions.

EPA's 2014 Framework is a revision of its 2011 Framework, which the SAB previously reviewed. The SAB notes that the 2014 Framework incorporated some of the SAB's prior advice and advanced the analytical foundation for making determinations about the net contribution of biogenic feedstocks to CO_2 in the atmosphere. Specifically, the 2014 Framework has incorporated the SAB's prior advice as follows:

- It has adopted an alternate fate approach (i.e., a counterfactual evaluation of what the net biogenic atmospheric contribution might have been if the feedstocks were not used for energy) to the collection and use of waste-derived feedstocks, including avoided methane (CH_4) emissions.

- It includes a discussion of the trade-offs inherent in the selection of a temporal scale for considering net emissions.
- It has developed representative BAFs by feedstock and region rather than facility-specific BAFs.
- It includes a review of existing approaches to addressing leakage, the phenomenon by which efforts to reduce emissions in one place affect market prices that shift emissions to another location.
- It offers an approach to construct an anticipated baseline that allows assessment of the additional CO_2 emissions to, or uptake from, the atmosphere that can be attributed to biogenic feedstocks as a result of changes in biomass feedstock demand.

The 2014 Framework does not, however, provide the ~~policy~~ regulatory context, specific BAF calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. The BAF is a *construct* designed to evaluate the importance of the stack emissions of CO_2 at a given time relative to their climate impacts at some point in the future when some of the emitted CO_2 may have been sequestered by regrowth of biogenic feedstocks. As such, the computation of the BAF for a feedstock in a region depends upon the future point in time that is of interest, which is a choice that depends upon the objective of interest. If the objective of interest for the BAF computation is defined by short term processes, then the relevant time-period for the BAF computation needs to be consistent. In addition to providing details on the objective to inform the relevant time frame, a ~~policy~~ regulatory context would have provided other information necessary to the assessment of the science underpinning the BAFs, such as the scale of demand for biogenic feedstocks and the anticipated time frame for that demand and eligible feedstocks to meet it. ~~Policy~~ Regulatory choices are expected to affect actions taken in feedstock markets, and these anticipated actions affect the assumptions in the models used to compute the BAF.

While the SAB agreed with many of the recommendations developed by the Biogenic Carbon Emissions Panel in previous drafts of the report, it disagreed with the extended time frame recommended for BAF computation. There was extended discussion between the SAB and the Biogenic Carbon Emissions Panel over the significance of the time horizon used to calculate BAFs. The Panel recommended that a general principle for determining the time horizon for BAF calculations should be to select a time horizon that fully accounts for the temporal dynamics for all feedstocks to accommodate the Agency's preference for a regulatory ~~policy~~-neutral approach. During quality reviews the SAB disagreed with this recommendation noting that for regulatory~~policy~~ initiatives that focus on objectives that reflect shorter time horizons it may not accurately capture the net carbon dioxide emissions relevant to that ~~policy~~ regulation if a BAF is calculated to incorporate nearly all carbon stock effects over a much longer period of time. The SAB favors selecting the time horizon for calculating the BAF to comport with the objective under consideration, which is generally incorporated into the regulatory~~policy~~ choice. The Panel's previous reports remain available on the SAB [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252?OpenDocument"].

As we stated in our 2012 report and we reiterate here: this SAB review would have been enhanced if the Agency offered a specific regulatory application that, among other things, provided explicit proposed BAF calculations and defined the applicable boundaries regarding upstream and downstream emissions

in the feedstock life cycles. The 2014 Framework lacks specificity and is written in a way that is too generic, with too many possibilities that would require assessment of different underlying science. Rather than offering a lengthy menu of calculation options, the EPA Framework needs to define its scenarios and justify those choices. This would enable the SAB to evaluate the science underpinning those decisions and justifications.

Despite this significant limitation, the SAB offers overarching suggestions for moving forward with a framework for assessing the BAFs of biogenic feedstocks. In addition we offer specific responses to EPA's charge questions when possible, the SAB offers general guidance regarding the calculation of BAFs. EPA's equations were based on emissions (fluxes) with some adjustment terms to account for carbon mass escaping the system between the point of assessment and the point of emissions. In the enclosed report, the SAB recommends an alternative formulation based on changes in terrestrial (non-atmospheric) carbon stocks (or pools) such as the live stocks in biomass, dead stocks, soil stocks, etc., that explicitly incorporates the principle of conservation of mass. While the carbon-stock-based accounting system results in a similar formula for BAF as the EPA's emissions-based approach, it offers multiple advantages: the component stocks are regularly inventoried and modeled by the scientific community; the different stocks can be aggregated and rearranged as needed or further subdivided; and it is appropriately constrained by conservation of mass and therefore the precision of the results can be assessed using mass balance calculations. Although this alternative formulation provides these benefits, other important modeling issues remain. These include selecting appropriate temporal or spatial boundaries, considering variability among classes of feedstocks, accounting for non-CO_2 greenhouse gases such as nitrous oxide and methane, and quantifying stocks and fluxes that are difficult to measure or estimate.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for carbon dioxide related to the use of biomass for electricity generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. We offer this caution about the model boundaries as defined by EPA's method and identified in the SAB review. In addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a whole different analysis and ~~policy~~regulatory response.

Finally, EPA did not ask the SAB for feedback on its modeling approach. We think this was an oversight, given that modeling is critical to the development of the BAF and different modeling approaches can yield different results. The 2014 Framework employed an integrated model that captures economic and biophysical dynamics and interactions for some of its alternative BAF calculations; however, EPA did not offer explicit justification for its modeling choices derived from articulated criteria. In addition, the sensitivity of BAF responses to some underlying features of the model was not examined by the EPA or the SAB. Thus, we conclude EPA should identify and evaluate its criteria for choosing a model or models and examine the sensitivity of BAF estimates to key modeling features.

The SAB appreciates the opportunity to provide advice on the 2014 Framework and looks forward to your response.

Sincerely,

Enclosure

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board (SAB), a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The SAB is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names of commercial products constitute a recommendation for use. Reports of the SAB are posted on the EPA Web site at [HYPERLINK "http://www.epa.gov/sab"].

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Acronyms and Abbreviations

AVOIDEMIT	Avoided Emissions
BACT	Best Available Control Technology
BAF	Biogenic Assessment Factor
BAU	Business as Usual
CH4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DOE	Department of Energy
EPA	Environmental Protection Agency
FASOM	Forestry and Agricultural Sector Optimization Model
GHG	Greenhouse Gas
GROW	Term in EPA's BAF equation representing net feedstock growth (or removals)
GWP	Global Warming Potential
PSD	Prevention of Significant Deterioration
N_2O	Nitrous Oxide
SAB	Science Advisory Board
USDA	U.S. Department of Agriculture

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1. EXECUTIVE SUMMARY

The EPA requested the SAB review a revised framework for accounting for biogenic carbon emissions, which the agency defines as "CO_2 emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, digestion, fermentation, decomposition, or processing of biologically based materials."[1] The goal of the 2014 Framework was to evaluate biogenic CO_2 emissions from stationary sources that use biomass feedstocks, given the ability of green plants to remove CO_2 from the atmosphere through photosynthesis. The 2014 Framework and its 2011 predecessor introduced the concept of a Biogenic Assessment Factor (BAF), which is the proposed adjustment for carbon emissions associated with the combustion of biomass feedstocks. The BAF is an accounting term developed in the Framework to denote the offset to stack emissions (mathematical adjustment) to reflect net carbon emissions after taking into account the sequestration of carbon in regrown biomass or soil, as well as emissions that might have occurred with an alternate fate had the biomass not been used for fuel.

Importance of Defining Objectives through the ~~Policy~~Regulatory Context

The questions before the EPA in 2011 and presented for the SAB's review, were whether and how to consider greenhouse gas (GHG) emissions and decisions about best available control technology (BACT) for CO_2 emissions from biomass feedstocks used for electricity generation at stationary facilities. EPA proposed to address this issue by defining a term, Biogenic Assessment Factor, intended to be used to assess effects *relative* to the desired objectives. The 2014 Framework; however, removed the ~~policy~~regulatory context, and did not include specific BAF calculations for any ~~policy~~regulatory context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. Thus, evaluation of this construct for a science-based regulatory framework in the absence of the defined objectives is not useful. Rather than assume a set of objectives (articulated in a ~~policy~~regulatory context) or evaluate the charge questions across numerous putative objectives of interest, the SAB focused on providing input on considerations that affect the usefulness and scientific integrity of EPA's approach.

The SAB notes that EPA's 2012 Framework report does not identify the specific metric of climate impact (or "objective") with resulting regulations that a BAF estimate should reflect, and further notes that BAFs that may be developed under the Framework could entail a wide range of objectives, e.g., temporal and spatial domains, total emissions, temperature, etc. While it may be desirable to identify a universal modeling methodology that could be applied to any of a wide range of potential objectives, the lack of specificity in the Framework document regarding the objectives to be estimated makes it very difficult for the SAB to assess whether the suggested types of models, data, and baselines are appropriate, and thus limits the ability of the SAB to fully address some of the charge questions. We thus preface the SAB's comments with this observation on the consequences of having made this revised 2012 Framework so general in its potential applications.

[1] [HYPERLINK "https://19january2017snapshot.epa.gov/climatechange/carbon-dioxide-emissions-associated-bioenergy-and-other-biogenic-sources_.html"]

Region- and Feedstock-Specific Biogenic Assessment Factors, baselines and modeling

As recommended previously by the SAB, BAFs should be feedstock-specific and region-specific and not facility-specific. Facility-specific BAFs are conceptually and practically challenging to estimate due to the absence of well-defined spatial boundaries for feedstock supply to each facility and the role of market-induced effects on land use, on biomass production and market demand for fiber, and on carbon stocks across space. To obtain a region-specific BAF for feedstocks, it is necessary to address region-specific, feedstock-specific demand for biomass and to assess the impact of this increased demand for biomass on net carbon stocks. Changes in demand for biomass feedstocks should be assessed based on historical data on forest carbon stocks, resource use, and observed information on current and planned expansions to facilities using biomass feedstocks. *There is no single answer to what these BAFs should be, as not all biogenic emissions are carbon neutral nor net additional to the atmosphere, and assuming so is inconsistent with the underlying science.*

Projections of the interactions that must be assessed to compute a BAF can be obtained from diverse model types, from simple empirically and statistically-based models, to complex integrated assessment models that combine biophysical and economic factors. The more complex the model, the greater the dependence of outputs on input assumptions and available data, which may limit the applicability of these models. For all model types, sensitivity and uncertainty analyses are needed to adequately interpret the results and understand the dependency of the BAF on the choices and assumptions used as part of its computation.

To compare changes in any system over time there must be a reference scenario (without increased demand for biomass feedstocks) against which to assess the net impacts on the variable of interest. In 2012, the SAB recommended a future anticipated baseline approach to capture the *additional* CO_2 emissions to, or uptake from, the atmosphere created by any increased use of biomass feedstocks for electricity generation. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis *along with* a reference point approach in its 2014 Framework. Both the future anticipated baseline and the reference point baseline (with regular updates) are challenging to apply due to data and modeling limitations.

Regardless of the baseline structure chosen (adjusted reference or future anticipated), validation and evaluation of the model used to compute the BAFs will be critical. Model validation is essential to assessing any model's ability to replicate observed phenomenon over time, ensuring that simulations based on the model are capturing expected behavior in the system. Similarly, understanding model sensitivity to input parameters and assumptions is important with respect to assessing model applicability over time. The model selected for estimating BAFs should be reviewed and updated at regular intervals, capturing observed changes in economic and land use conditions that may be due to increased biomass demand or other related conditions, as well as the latest scientific information on biophysical and biogeochemical properties of feedstocks. The appropriate review interval should be selected based on the timeframe of the ~~policy~~regulatory objective(s) as well as the timeframe associated with updates to the underlying data.

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Charge Question 1

Temporal and Spatial Scales

A sustained increased demand for biomass feedstocks by stationary facilities in a region is likely to trigger changes in carbon stocks through one or more pathways that could generate a new (steady-state) equilibrium stock of carbon that may be higher or lower than the current stock of carbon on the land. The demand for biomass feedstocks for use in stationary facilities can affect carbon stocks by increasing harvesting intensity for standing biomass, diverting biomass feedstocks from other non-energy products and landfills, converting land from other uses to plant new biomass feedstocks for the future, and utilizing biomass residues that might otherwise decay. Each of these responses may differ over time, and thus, the overall effect of all these responses together on demand for biomass feedstocks may differ over time. Therefore, the time period selected for the analysis can strongly affect the assessed impact of an increased demand for biomass feedstocks by stationary facilities on carbon stocks and net emissions of carbon dioxide to the atmosphere. The selection of the time period for assessment is not a scientific question, but rather is closely associated with the ~~policy~~regulatory objectives being addressed by the application of a feedstock-specific and region-specific BAF to a facilit(y/ies). For example, consider an objective to limit peak planetary warming versus an objective of controlling emissions of greenhouse gases in 2050: the same feedstock in the same region could have widely varying impacts on terrestrial carbon stocks because the timeframe defining the endpoint of the relevant analysis would differ. Since BAFs are computed by assuming a ~~policy~~regulatory objective, there are no scientific criteria by which to pick a single 'right' timeframe for their determination independent of the ~~policy~~regulatory context (Ocko et al 2017).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for the application EPA defines (stationary facility for energy production). A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks

Stock-Based Accounting Preferred to Emissions-Based Accounting

Carbon accounting associated with determining BAFs should be based on changes in carbon stocks on the land rather than changes in carbon emissions (as used in EPA's 2011 and 2014 Frameworks). A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated, subject to validation via mass balance and an existing comprehensive system of empirical measurements is already in place for the US. The stock-based approach comports with the current conventions in carbon accounting, which essentially use input-output tracking of carbon throughout a system with well-defined boundaries. These stocks can be aggregated and rearranged as needed, and they are appropriately constrained by conservation of mass and therefore can be assessed and precision determined using mass balance calculations.

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Charge Question 2

Scales of Biomass Use and Modeling Approach

Projections for aggregate demand for all biomass changes should be bounded by historical data on resource use, observed information on current and planned expansions to facilities using biogenic feedstocks, and reasonable projections of cost-effective deployment of biomass feedstocks for meeting the energy/feedstock needs of stationary facilities.

In addition, regular retrospective evaluations of observed levels of demand and the mix of feedstocks would enable revisions to EPA's estimates of feedstock demand. Retrospective evaluations of BAF performance will be important for understanding how effective the modeling has been in predicting what occurred. Thus, projections about biomass feedstock demand should be revised based on actual observations, and these updated demands should be used to inform modeling that generates BAFs.

Recommendations

1. An accurate biogenic carbon accounting approach utilizing Biogenic Assessment Factors will vary depending on the objectives for their development, which depend upon the ~~policy~~regulatory context, particularly in selection of the time horizon and geographic scope.

2. EPA should identify and evaluate its criteria for choosing a model and modeling features that affect BAF results. EPA should explore the sensitivity of BAFs to different modeling approaches, assumptions, transaction costs, and uncertainties in model input parameters.

3. Stationary facilities require a continuous supply of biomass feedstocks, thus a landscape approach is required for accounting for the impacts of feedstock demand on carbon stocks."

4. The direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no single optimal time horizon for evaluating these impacts.

5. Changes in carbon stocks (e.g., live and dead biomass, soil, products, material lost in transport and waste), should be used to account for biogenic carbon, rather than an emissions (flux-based) approach.

6. The SAB suggests exploration of two cumulative BAF metrics. Until the implications of the different metrics are clear, the SAB recommends using the metric proposed by EPA, i.e., net changes in stock over a specified time.

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2. INTRODUCTION

2.1. Background

EPA's Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (U.S. EPA 2014).

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for CO_2 emissions associated with the use of biogenic feedstocks in stationary facilities, taking into account the biological carbon cycle associated with the growth, harvest, and processing of plant biomass. This mathematical adjustment to stack emissions is needed because of the unique ability of biological systems to sequester CO_2 from the atmosphere through photosynthesis in living biomass, to sequester carbon in dead biomass and soil, and to release CO_2 through respiration and biologically-mediated decay of organic matter. These attributes of ecosystems mean that there can be wide variation in the net effect of using biomass feedstocks in stationary facilities on emissions of carbon dioxide to the atmosphere and thus it is scientifically indefensible to assume all bioenergy has no net carbon dioxide emissions to the atmosphere, or the reverse, that all emissions represent a net addition to the atmosphere. The Biogenic Assessment Factor is an accounting term developed in the Framework to estimate the net CO_2 emissions to the atmosphere over a specified period of time associated with burning biomass feedstocks to produce energy. These net emissions reflect the changes in carbon stocks of above and below ground biomass (live and dead), soils, and wastes. The 2014 Framework is a revision of the 2011 Framework (U.S. EPA 2011), which the SAB previously reviewed (U.S. EPA SAB 2012).

The EPA's charge to the SAB (Appendix A) requests advice and recommendations on its revised 2014 Framework, which was developed with consideration of the SAB's 2012 recommendations as well as the latest information and input from the scientific community and other stakeholders. The EPA asked the SAB to review and offer recommendations on specific technical elements of the 2014 Framework for assessing the extent to which the production, processing, and use of biogenic feedstocks at stationary facilities results in net emissions of CO_2 to the atmosphere so that it could be quantified through calculation of a BAF. The 2014 Framework does not, however, provide the ~~policy~~regulatory context, specific Biogenic Assessment Factor calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks.

To conduct the present review, the SAB Staff Office reconstituted the Biogenic Carbon Emissions Panel (Appendix B), which had reviewed the 2011 Framework. That panel met multiple times between March 2015 and August 2017. The Panel presented a draft report (February 2016) to the SAB for quality review. The SAB quality review was conducted in March 2016; this quality review resulted in requested revisions from the Panel. The revised draft report (June 2017) was reviewed by the Board in 2017. The 2017 revision of the report was not approved by the SAB based on the deliberations of the quality review. The present report is a product of SAB's direct efforts and utilizes portions of the Panel's report. Previous drafts of the Panel's report are retained on the SAB website and available [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235dac747c16fe985257da90053f252!OpenDocument&TableRow=2.2" \l "2."].

The SAB notes that EPA's 2012 Framework report does not identify the specific metric of climate impact (or "objective") that a BAF estimate should reflect, and further notes that BAFs that may be developed under the Framework could entail a wide range of objectives, depending on the regulation or policy-specific approach that would require use of a BAF. (For example, some regulations may impose objectives related to different time horizons than others; similarly, under some regulations the BAF may need to address a temperature impact objective, while other regulations may impose a net CO_2 emissions objective.) Any BAF must be estimated using a model that has the scope and temporal detail necessary to simulate the key economic, emissions and atmospheric phenomena to relevant to predicting that BAF's objective. Lack of specificity in the Framework document regarding the objectives to be estimated makes it very difficult for the SAB to assess whether the suggested types of models, data, and baselines are appropriate. While it would, in this situation, be desirable to identify a universal modeling methodology that could be applied to any of a wide range of potential objectives, this poses significant new analytical and data challenges on the Framework. It also limits the ability of the SAB to fully address some of the charge questions. We thus preface the SAB's comments with this observation on the consequences of having made this revised 2012 Framework so general in its potential applications.

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3. OVERARCHING COMMENTS

This section addresses issues that lie outside the scope of EPA's charge questions, but which the SAB considered critical to place the responses to the charge questions in context. The charge questions are narrowly focused on specific technical aspects in the structure of the 2014 Framework. However, the SAB had important general advice regarding the Framework. This first section outlines that advice.

3.1. Defining Objectives through the ~~Policy~~Regulatory Context

For its review of the 2011 Framework, the SAB requested and was given a ~~policy~~regulatory context for the biogenic CO_2 accounting framework. The SAB was told that the 2011 Framework was intended to guide the determination of CO_2 emissions from regulated stationary sources under the Clean Air Act, specifically those facilities receiving a prevention of significant deterioration (PSD) air permit and that were required to conduct a best available control technology (BACT) analysis for CO_2 emissions. The question before the agency, and hence the SAB, was whether and how to consider biogenic greenhouse gas (GHG) emissions in reaching thresholds for permitting and decisions about BACT for CO_2 emissions from the use of bioenergy in stationary facilities.

The agency has removed this ~~policy~~regulatory context from its 2014 Framework, and the EPA's charge questions seek general guidance on issues related to the choice of temporal, spatial and production scale for determining BAFs in a ~~policy~~regulatory-neutral context. In the absence of a specific ~~policy~~regulatory context, which would provide the objectives against which the BAF will be evaluated, this review was limited to providing general comments about how to consider the questions posed. More specific answers to the questions posed will vary with the objective (as defined by the ~~policy~~regulatory context), most notably the appropriate time period over which to determine the net biogenic emissions, and to a lesser degree, the appropriate geographical scale for consideration.

A ~~policy~~regulatory context with explicit objectives would clarify if the proposed procedures for determining the BAF will account for the emissions of all greenhouse gases that alter the climate. If this is the case, then it will be important to account for the effect of biogenic feedstocks on non-CO_2 gases such as N_2O and CH_4, to examine how the emission or uptake of these gases differ across space, time, and feedstocks, and to examine how these gases influence BAFs. Given the large difference in the mean residence time of these gases in the atmosphere, their relative importance can vary widely over different time horizons. If the climate impacts over 20 or 40 years is of concern, then methane and carbon particulate emissions could be very important, while if the period of concern is hundreds of years, their importance will drop significantly (Shoemaker, et. al., 2013). Non-CO_2 gases are particularly important for feedstocks grown with nitrogen fertilizer and for waste materials from landfills.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for carbon dioxide related to the use of biomass in stationary facilities for energy generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. If, for example, biomass pellets were sourced from old growth forests, this would pose unique risks that would not be reflected in a BAF calculated for net effects on carbon dioxide. We offer this caution about the model boundaries as defined by EPA's method and identified in the SAB review. In

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addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a different analysis and ~~policy~~regulatory response.

Recommendation

- Biogenic Assessment Factors will vary depending on the objectives for their development, which depend upon the ~~policy~~regulatory context, particularly in selection of the time horizon and geographic scope. Thus, future efforts to define specific biogenic accounting factors should be conducted in a ~~policy~~regulatory-specific context, with the objectives and relevant time frame specified. It is inappropriate to use default assumptions, including assuming there are no net emissions or that all emissions are additive.

3.2. Baseline Approach

To compare change in any system over time, there must be a baseline scenario against which to assess changes, in this case, changes due to demand for biogenic feedstocks; a baseline allows different scenarios to be compared. In the 2011 Framework, the EPA assesses the estimated net change in land-based biogenic CO_2 fluxes and/or carbon stocks between two points in time, with the first time point called the reference point. In the 2012 SAB report, we noted temporal problems with the reference point baseline approach. The EPA has acknowledged this in its 2014 Framework and included a future anticipated baseline analysis alternative along with a reference point baseline approach. The 2014 framework notes that the choice of baseline (reference point or anticipated) depends on the question to be answered and the specific context in which the framework is applied.

The SAB's 2012 advice on the anticipated baseline approach explored the use of complex modeling in order to try to capture interactions among the market, land use, investment decisions, and emissions and ecosystem feedbacks, and to construct a counter-factual scenario that does not include increased bioenergy use. In the case of long rotation feedstocks, biomass feedstock demand can affect carbon stocks in many ways including the age of trees harvested, the diversion of forest biomass from traditional forest product markets to bioenergy, and the rates of afforestation and deforestation. Estimating the net effect of these changes on carbon stocks requires a model that integrates market demand and supply conditions with biophysical conditions that determine growth of forest biomass, losses via decomposition, carbon sequestration and fluxes due to harvests and land use change and incorporates the spatial variability in these effects across the U.S. The complexity of such a modeling approach can make it difficult to parameterize and validate and requires a sensitivity analysis of parameters and model assumptions. The lack of empirical data regarding many of these relationships and the resulting uncertainties pose a significant challenge to use of this type of model in a regulatory context.

Also, consistent with the SAB's 2012 recommendations, the EPA has now moved toward a "representative factor" approach that would include an assessment of the biogenic landscape attributes (type of feedstock, region where produced). The EPA initially considered calculating a BAF for an individual stationary facility; however, the data needs for a facility-specific approach are daunting if they are to be accurate (e.g., case-specific measurements and calculations of carbon stocks and chain-of-custody carbon accounting, integration of land use changes on a broader landscape level). EPA's use of

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a representative factor approach is an advance in its accounting methodology, although overly-broad feedstock categories may not reflect important extant or likely future variation in feedstock production or processing (e.g., roundwood in the Southeast, logging residues in the Pacific Northwest, and corn stover in the Corn Belt). The overall approach is a positive development, but caution is required to ensure such inclusiveness does not produce unintentionally negative outcomes, e.g. feedstocks with large net emissions to the atmosphere lumped together with those with more limited net emissions. The EPA should evaluate the "representativeness" of the factors and refine the approach over time with additional data.

As stated in the SAB's 2012 report, there are tradeoffs between ease of implementation (transaction costs), precision (getting it right at every location), accuracy (getting the overall stock change correct), and ~~policy~~regulatory effectiveness (ensuring that the ~~policy~~regulatory objectives are being met). The SAB continues to recognize the difficulty of undertaking the recommended anticipated baseline approach, and practicality should be an important consideration in the agency's decision making. While the reference point baseline approach has significant limitations as noted in the SAB's 2012 report, these might be overcome if regular updating with empirical data to capture regional carbon stock changes (increases or decreases) were employed All methods considered should be subject to an evaluation of the costs of implementation and compliance and weighed against any increase in accuracy and precision that they might yield. Ultimately it is critical that there is a balance between accuracy and minimization of implementation costs.

Recommendation

- The EPA should identify and evaluate its criteria for choosing a model and its underlying assumptions with regards to how these criteria and assumptions affect calculated representative BAFs. In addition, the EPA should periodically update and validate the selected model to incorporate the latest scientific knowledge while ensuring that the model outputs are consistent with empirical observations (e.g. shifts in measured carbon stocks as determined the Forest Inventory Analysis program). Any model chosen should be subject to sensitivity analysis to evaluate its efficacy under different conditions and to identify data needs and prioritize future research.

3.3. Alternate Fate Approach for Waste-Derived Feedstocks

In 2012, the SAB recommended that the EPA consider alternative fates (i.e., if not used as fuel for electricity generation or process heat) of waste-derived feedstocks diverted from the waste stream, e.g., whether these feedstocks might decompose over a long period of time, whether they would be deposited in anaerobic landfills, whether they would be diverted from recycling and reuse, etc. In the 2014 Framework, the EPA has conducted extensive alternate fate calculations; however, the agency drew a narrow boundary around point source emissions and neglected other significant considerations that affect the GHG footprint of alternative municipal solid waste management scenarios. Specifically, the EPA neglected to quantify a potential alternate fate of municipal solid waste through landfill-derived methane combustion. Under the Clean Air Act New Source Performance Standards, the EPA requires landfills above a certain size to, at a minimum, collect and control landfill gas (e.g., through flaring or use). As such, a baseline of direct venting is misleading, although almost all these facilities are likely to produce large emissions of methane, even when in compliance with current regulations (Lamb et al 2016: [HYPERLINK

"file:///C:\\Users\\tcarpent\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\9EYAZ1S8\\www.epa.gov\\lmop\\basic-information-about-landfill-gas"]). The relative rankings of BAFs across waste treatment options assessed in the 2014 Framework might change considerably if a more complete accounting were undertaken (e.g., energy recovery from landfill-derived methane and combustion of waste, and carbon storage associated with landfills

3.4. Temporal and spatial considerations in Biogenic Assessment Factor Calculations

The goal of the EPA Framework reviewed is to account for effects of biomass feedstocks used for energy generation at stationary facilities on terrestrial carbon stocks. BAFs are a carbon accounting method based on expected future changes in carbon stocks (measured in tons of carbon). They are designed to assess the net contribution of CO_2 from a stationary facility that uses biomass feedstocks, due to shifts of terrestrial carbon to and from the atmosphere over a specified period of time. The time scale selected will vary depending on policyregulatory-defined objectives (e.g. reduction of GHG emissions in 2050 or 2100, or minimizing global temperature change resulting from greenhouse gas emissions). Over the selected time period, all greenhouse gas impacts (not just CO_2) – both positive and negative – should be accounted for (as completely as is feasible).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for the application EPA defines (stationary facility for energy production). A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks. As noted by Cintas et al. (2016), "assessment at the landscape scale integrates the effects of all changes in the forest management and harvesting regime that take place in response to – experienced or anticipated – bioenergy demand. Taken together, these changes may have a positive, negative or neutral influence on the development of forest carbon balances." Landscape level accounting of effects of forest-based feedstocks on carbon stocks can result in a net gain or loss of carbon stocks in the near to medium term; a carbon debt could be followed by a carbon dividend or the other way around.

BAFs are a carbon accounting tool for assessing CO_2 emissions from facilities that consume biomass feedstocks for production of energy and are not life cycle assessments of net greenhouse gas emissions or their climate change effects. The distinction is that not all indirect systemic effects are considered in the BAF, nor are all GHG effects included. We also underscore our caution that the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, policyregulatory efforts, market forces, or natural causes. If such monitoring demonstrates changes that are not included in the model used to develop the BAF, the BAF should be updated to align with the empirical data.

Recommendation

- Stationary facilities require a continuous supply of feedstock, thus a landscape approach is required for accounting for the impacts of feedstock demand on carbon stocks.

RESPONSES TO EPA'S CHARGE QUESTIONS

3.5. Temporal/spatial Scale for Biogenic Accounting

Charge Question 1: What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

There are several key factors that impact the dynamic nature of the BAF for a specific feedstock and region. The first is that the increased demand for biomass feedstocks in a region could potentially be met by a variety of sources obtained from the agricultural and forestry sectors, including annual and perennial agricultural crops, short rotation woody biomass and pulpwood, and crop and forest residues. Any increase in demand might involve using a larger proportion of an existing resource or diversion from non-energy products and landfills, converting land from other uses to growing biomass feedstocks, changing use of existing feedstocks, utilization of residues that would otherwise decay over some period of time. The effect of increased demand for biomass feedstocks on carbon stocks will depend on the mix of these feedstocks demanded and the scale of demand for these feedstocks.

Second, different biomass sources have different effects on carbon stocks over different timeframes. The plant systems, e.g. forests, agronomic systems, producing feedstocks differ in their rate of growth/regrowth, yield, potential to sequester carbon in biomass and soils, decay rates after harvest, and the type of land-use change that accompanies their production. These effects continue after the feedstock has been consumed by a stationary facility. We therefore recommend computing a cumulative BAF over the relevant time horizon. This cumulative BAF would be based on the difference in carbon stocks between a scenario without change (either computed using a reference point or anticipated baseline) and the increased biomass feedstock demand scenario and would vary with the time horizon selected by the objective in the relevant ~~policy~~regulations.

Key principles for calculating changes in the net carbon stocks should include: (1) the positive and negative impacts of demand for biomass over time, (2) a system-wide (landscape and economy) approach to account for direct and indirect effects, and (3) consistency across each region. Selecting different time horizons for different feedstocks being used to meet the same ~~policy~~regulatory objective would be inappropriate as it would yield inconsistent effects.

Determining the scale of appropriate regions for calculating BAFs will require balancing similarity in the biophysical characteristics, similar growing conditions (growing season length, vegetation type) and economic factors, biomass demand, with ensuring that the edge to volume ratios of the regions are small enough to ensure minimizing incentives to manipulate the movement of biomass feedstocks among regions due to differing BAFs.

To fully account for all positive and negative terrestrial effects over time, we recommend using the "emissions horizon" as described by the 2014 Framework applied to a specific ~~policy~~regulatory objective. As defined by the EPA, this "emissions horizon is the period of time during which the carbon fluxes resulting from actions taking place today actually occur …" (U.S. EPA 2014). If the objective is to have an effect on greenhouse gas emissions by a certain date, then the impacts aggregated by that date are the relevant metric to assess meeting the objective, and that date is the appropriate time horizon. Accordingly, there is no single time horizon that will effectively address all policies or feedstocks since feedstock net effects are time-dependent and desired objectives for ~~policy~~regulatory changes target different time horizons. The SAB does not support a single time horizon as appropriate for determining BAFs, because the computed values can vary significantly over differing time horizons and different objectives will be met over different time horizons.

The Panel suggested that the time horizon should be the length of time it would take for the effect of increased demand for biogenic feedstock on the carbon cycle to reach a steady-state. This occurs when the difference in carbon stocks between the increased biomass feedstock demand scenario and the business-as-usual scenario is no longer changing or when the difference is approaching an asymptote. This could result in a very long time horizon being selected, potentially hundreds of years if all feedstocks across all regions were to be included. The selection of such a time horizon would mean that for ~~policy~~regulatory objectives with shorter time horizons (e.g., meeting a 2050 emissions target), the accounting would not align with relevant effects of biomass feedstock use at stationary sources on the ~~policy~~regulatory objective.

Several factors determine the difference in carbon stocks between the business-as-usual scenario and the increased biomass feedstock demand scenario. A major factor is the "speed" with which carbon stocks respond after harvest; this can be influenced by several factors: the speed with which a feedstock regrows and can be harvested again, the mix of feedstocks produced, and the rate at which soil carbon stocks change. Thus, the mix of feedstocks used can influence the shape of the curve and when it reaches equilibrium.

Previous studies have shown that estimates of the effects of biomass harvest on carbon stocks depend on the spatial scale of consideration (stand level or landscape level), the initial conditions of carbon stock on the land (e.g., managed forestland, old growth forestland, or agricultural land), the management practices used, and the time horizon over which effects are measured (Walker et al., 2010; Jonker et al., 2014; Mitchell et al., 2012; Galik and Abt, 2012; Ter-Mikaelian et al., 2015). Harvest of an existing forest stand for use as a feedstock results in an immediate reduction of carbon on the site; the amount of carbon lost at the stand level is directly related to the intensity of the disturbance. At a stand level, harvest followed by regrowth (most US forests regenerate without intervention/planting) usually results in a cycle of loss followed by gain. The amount of carbon regained on the site can vary: in some cases, all is regained, in others only part is regained, and in others, more can be gained than is released.

Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed asynchronously; the order in which losses and gains occur becomes meaningless at the landscape level because both simultaneously occur. Thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs for biomass feedstocks used at stationary sources. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net

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loss of carbon to the atmosphere at the landscape level, compared with the business -as-usual scenario, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.

Biomass, particularly from forest sources, is also used for producing non-energy products. The demand for biomass feedstocks for energy generation can lead to a diversion of biomass from those products and lead to an immediate reduction in carbon stocks in products. It is also possible that anticipation of future demand for biomass feedstocks by stationary facilities could lead to land conversion, reforestation and retention, or accumulation of carbon stocks in a growing forest. In general terms, the amount of either net loss or net gain of carbon on the landscape is influenced by changes in many factors including those influencing net primary production and removals, and the net effect can be expected to vary over time.

When agricultural feedstocks that are harvested annually from land under continuous production, the time lag between harvest, CO_2 emissions from conversion to energy, and regrowth on land is likely to be close to one year, and the harvested carbon will be fully regained, with no net impact on above-ground carbon stocks. The production of these feedstocks may directly affect carbon stocks below-ground by increasing or decreasing soil carbon stocks relative to the use of the land in the business-as-usual scenario. The demand for biomass feedstocks can also affect carbon stocks by leading to a change in the use of land which could either release carbon stored in the land (for example if permanent grasslands are converted to annual agricultural production) or accumulate carbon on the land (for example through reforestation as annual cropland is converted back to forests).

Recommendation

- The direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no single optimal time horizon for evaluating these impacts.

Charge Question 1(a): Should the temporal scale for computing biogenic assessment factors vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.

Charge Question 1(a)(i). If temporal scales for computing biogenic assessment factors vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?

Charge Question 1(a)(ii). Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?

Charge Question 1(a)(iii). Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default biogenic assessment factors versus crafting policy specific biogenic assessment factors?

Charge Question 1(b). Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?

The responses to questions 1(a), 1(a)(i), 1(a)(ii), 1(a)(iii), and 1(b) are combined because these questions all relate to goals or criteria that may affect choices of differing temporal scales for calculating BAFs.

Question 1a asks specifically if the temporal scale for computing Biogenic Assessment Factors should vary by regulatory policy. As noted in the overall response to Charge Question 1 (above), the SAB concludes that the BAF computation should be informed by the ~~policy~~regulatory objectives, particularly with respect to time.

If there are multiple objectives in multiple policies (as discussed in charge question 1(a)(i), there are no overriding scientific principles that can be applied *a priori* to guide alignment among these multiple objectives.

One could advocate for a host of approaches to selecting a time horizon for evaluation; all would be plausible but not inherently aligned with the objective of the ~~policy~~ regulations being promulgated. At the extremes one could consider only the carbon accounting over the year in which the biomass was combusted; such an approach would mean that almost all feedstocks would be assigned a BAF close to one, representing no net benefit to reducing atmospheric carbon dioxide concentrations. Conversely one could only consider net impacts on the carbon cycle over several hundred years, which would mean for most feedstocks the BAF would be close to zero (assuming steady demand and unchanged rotation lengths thus allowing stocks to come into equilibrium), indicating all biogenic emissions being net beneficial to the atmosphere. Neither of these approaches would align with the most likely objectives of a biogenic accounting framework; however, neither is inherently correct or incorrect.

The time horizon for consideration of carbon stock changes should be chosen based on the objective (e.g., minimizing net greenhouse gas emissions over a specified period or temperature increase by a certain date), which would be aligned with the ~~policy~~regulatory goals. The SAB makes no assertion regarding the appropriate ~~policy~~regulatory use of the BAF and thus supports no specific time horizon selected independent of a ~~policy~~regulatory objective.

Charge Question 1(c). Should calculation of the biogenic assessment factor include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?

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Accumulating all effects of the use of a biogenic feedstock over a time horizon is preferred to a marginal or instantaneous ("per period") BAF. (For the purposes of answering this question, the SAB interprets "marginal" to mean "annual" or "per period" so as to distinguish it from the meaning of "marginal" that typically refers to the last unit of emissions or the additional effect of the last unit of biomass.)

As described in the overall response to Charge Question 1 (above), the SAB recommends a cumulative carbon accounting metric; however, there are alternative ways to calculate cumulative BAFs. EPA's cumulative BAF (called BAF_T in the 2014 Framework) applied to stocks is one option, reflecting the carbon stocks at the end of the time horizon—specifically, changes in carbon stocks by time, T. One can also calculate a cumulative BAF that is based on the accumulation of annual differences in carbon *stocks* on the land *over the time horizon until equilibrium is reached*, here called $BAF_{\Sigma T}$. By accumulating annual differences across the projection period, this alternative cumulative BAF metric attempts to incorporate "residence time" in the sense that it is a proxy for the length of time carbon stays in the atmosphere until it is modified by changing stocks of carbon on the land. While intended to generate a single BAF term at the end of the selected time horizon, either computation can be evaluated at any time of interest. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach, i.e., the difference in carbon stocks *at the end of the selected time horizon*.

The choice of an appropriate cumulative BAF should be informed by a scientific assessment of the dynamics of additions to atmospheric carbon stocks as well as the complexities and uncertainties of these determinations, ensuring the accounting is accurate and verifiable. Both cumulative BAFs attempt to capture net changes in biogenic carbon stocks. A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated and are still subject to mass balance.

With either approach to evaluating BAFs, caution is advised with projections into the future. A BAF is inherently based on some type of modeling that employs assumptions about the relationship of variables in the future based on current observations. These assumptions may not be robust in the future. Each BAF will need to be assessed periodically to see if changing conditions warrant a revision (Bucholz et al. 2014).

Carbon accounting for biogenic emissions can either be framed using differences in carbon emissions to the atmosphere or using differences in carbon stocks on the land. Conservation of mass dictates that any carbon taken from the land (through increased harvests or other disturbances) will result, in the near-term, in equivalent increases of carbon in the atmosphere, followed by longer-run changes in ocean and land-based carbon. Thus, these approaches are compatible, but examining changes in stocks is operationally more direct and can be done periodically, rather than requiring continuous measurements to be accurate. However, both approaches should account for changes within the boundaries of the analysis, such as import and export of biogenic feedstocks and other associated products.

Long-Term Trends in Biogenic Assessment Factors

The Panel has suggested that cumulative BAFs might approach zero as T is reached. However, that is only true for $BAF_{\Delta t}$ and not the cumulative BAFs. Mathematically cumulative BAFs are hyperbolic functions once T is reached and have extremely long "tails", representing a period of net CO_2 emissions to the atmosphere.

An approach to determining a baseline that includes an historical time period could be used to periodically reset a reference baseline based on re-measuring carbon stocks on the landscape using data from existing inventory programs. Carbon stock measurements have been made for more than a half century in the US, offering a robust record of change. This approach could improve the accuracy of the baseline over time; however, as noted above, the preference for use of a reference or future anticipated baseline depends on the objective. Future changes in growth-to-harvest ratios could be used to inform the model assumptions and modify the BAF that would be applicable going forward. This could create long-term incentives for sustainable management of land resources. In any accounting framework that assumes future regeneration and regrowth, it is important to periodically test this assumption against actual data as they become available. If assumptions of future regeneration and regrowth are not supported by observations, adjustments need to be made to models that are used to determine BAFs.

Recommendations

- The SAB recommends formulating BAFs based on changes in carbon stocks (terrestrial pools such as live, dead, soil, products, material lost in transport and waste), rather than an emissions-based (flux-based) approach, because the former comports with conventional carbon accounting, has well-defined boundaries, and follows the conservation of mass.

- The SAB suggests consideration of two cumulative BAFs—that proposed by EPA and an alternative metric that takes into account the changes in terrestrial carbon stocks over time. The appropriate cumulative metric for calculating BAFs will depend on the understanding of the carbon system and climate response for which there is uncertainty.

Charge Question 1(d). What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions ex post), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is appropriate to periodically revise the modeling and the BAFs. The goal of such revisions would be to update underlying economic and biophysical assumptions and modeling trends in light of new data to reduce uncertainty and to increase accuracy of future projections.

A retrospective comparison would compare model-projected behavior to newly available historical observations and estimates, such as regional feedstock demand, land-use changes (e.g., reforestation, management intensity, forest rotations characteristics and conversion of land to other land uses including dedicated energy crops), and forest carbon measurements and estimates (both level and composition). It would be important to re-examine parameters, functional forms, and other assumptions of the modeling approach as part of an *ex post* evaluation.

3.6. Scales of Biomass Use

Charge Question 2: What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?

Charge Question 2(a). Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
Charge Question 2(b). What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?

The responses to questions 2(a) and 2(b) are combined below because both questions relate to the size of the simulated change in demand for biomass feedstocks. The complexities are large and any predictions on scale of demand shock can only be done effectively in a ~~policy~~regulatory context as they are very challenging to define otherwise.

If the EPA's goal is to obtain a region-specific BAF for a feedstock, it will be necessary to project region-specific and feedstock-specific demand for biomass. Since the BAF for a feedstock could differ depending on the method of production (for example, the soil carbon implications of corn stover will depend on the type of tillage practice used and the amount of residue harvested), it will be appropriate to have the BAF for a feedstock in a region reflect the methods used to produce that feedstock. To the extent that BAFs depend on technology and emissions control regulations at a stationary facility in a region, they could also be defined in terms of specific technologies.

Charge Question 2(c). Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?

In the absence of a specific ~~policy~~regulatory to model, the SAB cannot offer general recommendations for a representative scale of demand shock.

Charge Question 2(d). Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?

Charge Question 2(e). For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).

The responses to questions 2(d) and 2(e) are combined because both questions relate to modeling biomass feedstocks in isolation or jointly.

In the absence of a mandate for use of specific feedstocks or incentives for specific types of bioenergy which might be prescribed in a ~~policy~~regulatory framework, and which would inform the feedstock-specific demand that should be modeled, a reasonable approach is to model the aggregate demand for feedstocks. This approach assumes facilities are constantly seeking their least-cost alternative. An aggregate demand could be imposed on the model and used to determine demand for different feedstocks in different regions. This would allocate demand across feedstocks as well as within each

category to simulate a given target aggregate demand determined by the market's ability to draw from the least cost combination of feedstocks.

Charge Question 2(f). How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?

Default BAFs would likely vary by the scale of demand. In fact, a single set of default BAFs is unlikely to be robust across a wide range of scales of demand. The scale of demand is likely to influence the mix of feedstocks that is viable to produce because it can be expected to affect the market price of biomass. Low levels of demand for biomass may be met relatively easily by crop residues, forest residues and mill residues; high levels of demand could lead to dramatically increased harvests of forest biomass or production of dedicated energy crops. The BAF of a feedstock in a region can be expected to vary depending on whether there is a 1-million-ton increase in biomass demand or a 1-billion-ton increase in biomass demand.

In the absence of information about the scale of demand, BAFs could be determined for different threshold levels of aggregate demand for biomass feedstocks and consequent feedstock/region-specific demand.

Charge Question 2(g). Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?

While the methodological framework for different policies could be similar, we expect differences as follows: (1) BAFs that are tied to a particular regulatory ~~policy~~approach, versus a particular period of time, would be based on simulating the aggregate and feedstock-specific demand that is expected to emanate from that ~~policy~~regulation, while ~~policy~~regulatory neutral factors would be based on various exogenously specified quantities of demand for biomass and corresponding endogenously determined levels of feedstock specific demand, and (2) different policies may require different production and use practices, and thus result in different biogenic factors. Isolating the extent to which expected increase in demand for biomass and its consequences for CO_2 emissions can be attributed to a specific ~~policy~~regulation (when there are multiple policies inducing a shift to renewable energy) is likely to be complicated and challenging to convert into ~~policy~~regulatory-specific BAFs. It could also create unintentionally negative incentives for feedstock choice to comply with various policies.

Charge Question 2(h). What considerations could be useful when evaluating the performance of the demand shock choice ex post, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is likely that the observed feedstock demand in response to a specific ~~policy~~ regulation will differ from the forecast because the ~~policy~~regulation can be expected to increase demand for feedstocks with lower BAF and decrease demand for feedstocks with a high BAF. Since feedstock-specific demand and the feedstock BAFs are likely to be jointly determined, while the approach proposed above determines them sequentially, divergence between model simulated demand for feedstocks and observations is inevitable.

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An evaluation using actual data would also allow revisions to the EPA's estimates of feedstock demand changes (as discussed in response to Question 1d) based on updated data. To improve the performance of the model for assessing BAFs retrospectively, quantities of biomass feedstock (by feedstock category) harvested could be updated with actual observations. New data should improve the estimate of the portion of total biomass demand that is attributable to stationary facilities. This information could be used to improve BAFs.

REFERENCES

Bucholz, T., Prisley, S., Marland, G., Canham, C. and Sampson, N. (2014) Uncertainty in predicting GHG emissions from bioenergy. *Nature Climate Change* 4:1045

Cherubini, F., Guest, G. and Stromman, A. (2012). Application of Probability Distributions to the Modeling of Biogenic CO2 Fluxes in Lifecycle Assessment. *Global Change Biology Bioenergy* 1 - 15.

Cintas, Olivia, Göran, B., Cowie, A., Egnell, G., Holmstrom, H., Marland, G and Ågren, G. (2017). Carbon balances of bioenergy systems using biomass from forests managed with long rotations: bridging the gap between stand and landscape assessments. *Global Change Biology Bioenergy*. Retrieved from doi: 10.1111/gcbb.12425, 2017

Galik, C.S. and Abt. R.C. (2012). The effect of assessment scale and metric selection on the greenhouse gas benefits of woody biomass. *Biomass and Bioenergy* 44:1–7.

Galik, Christopher S, and Robert C. Abt. (2012). "The Effect of Assessment Scale and Metric Selection on the Greenhouse Gas Benefits of Woody Biomass." *Biomass and Bioenergy* 44 (September): 1–7. doi:http://dx.doi.org/10.1016/j.biombioe.2012.04.009.

IPCC (Intergovernmental Panel on Climate Change). (2007). *Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007.* Cambridge, United Kingdom and New York, NY. Retrieved from [HYPERLINK "http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf"].

Jonker, Jan G.G., Junginger, M. and Faaij, A. (2014). "Carbon Payback Period and Carbon Offset Parity Point of Wood Pellet Production in the South-Eastern United States." *Global Change Biology Bioenergy* 6 (4): 371–89. doi:10.1111/gcbb.12056.

Lamb, B.K., Cambaliza, M.O.L., Davis K.J., Edburg, S.L., Ferrara, T.W., Floerchinger, C., Heimburger, A.M.F., Herndon, S., Lauvaux, T., Lavoie, T., Lyon, D.R., Miles, N., Prasad, K.R., Richardson, S., Roscioli, J.R., Salmon, O.E., Shepson, P.B., Stirm, B.H. and Whetstone, J. (2016) Direct and Indirect Measurements and Modeling of Methane Emissions in Indianapolis, Indiana *Environmental Science and Technology.* 50: 8910-8917

Mitchell, Stephen R., Harmon, M.E. and O'Connell, K.E.B. (2012). "Carbon Debt and Carbon Sequestration Parity in Forest Bioenergy Production." *GCB Bioenergy* 4 (6): 818–27. doi:10.1111/j.1757-1707.2012.01173.x.

National Council for Air and Stream Improvement. (2015). Comment to the Biogenic Carbon Emissions Panel of the EPA Science Advisory Board. August 5, 2015. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/254A0104C4745E5785257E98006493E4/$File/NCASI+comments+for+Aug.+6,+2015.pdf"]

Ocko, I.B., Hamburg, S.P., Jacob, D.J., Keith, D.W., Keohane, N.O., Oppenheimer, M., Roy-Mayhew, J.D., Schrag, D. P. and Pacala, S.W. (2017*)* Two-valued Global Warming Potential Effectively Captures Long- and Short-term Climate Forcing. *Science.* 356:492-493

Shoemaker, J.K., Schrag, D.P., Molina, M.J. and Ramanathan, V. (2013). "What Role for short-Lived Climate Pollutants in Mitigation Policy?" *Science* 342: 1323-1324.

Ter-Mikaelian, Michael T., Colombo, S.J. and Chen, J. (2015). "The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions? A Review of Common Misconceptions about Forest Carbon Accounting*." Journal of Forestry* 113 (1): 57–68.

U.S. EPA (Environmental Protection Agency). (2011). *Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources.* Office of Atmospheric Programs. Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886/$File/Biogenic_CO2_Accounting_Framework_Report_LATEST.pdf.

U.S. EPA (Environmental Protection Agency). (2014). *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources.* Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf//LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252/$File/Framework-for-Assessing-Biogenic-CO2-Emissions+(Nov+2014).pdf.

U.S. EPA (Environmental Protection Agency). (2015). *Response to the SAB Panel Peer Review Advisory*. Retrieved from SAB Biogenic Carbon Emissions Panel Meeting Webpage. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/SABPRODUCT.nsf/5295DAC6053510F285257DFD0075C181/$File/OAR+Response+to+SAB's+2012+Advice.pdf"].

U.S. EPA SAB (U.S. EPA Science Advisory Board). (2012). *SAB Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources*. Retrieved from SAB website : [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf"].

Walker, Thomas, Cardellichio, P., Colnes, A., Gunn, J., Kittler, B. Perschel, B., Recchia,C. and Saah, D. (2010). "Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources." Manomet Center for Conservation Sciences, no. June: 182. doi:NCI-2010-03.

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APPENDIX A: CHARGE TO THE SAB

February 25, 2015

MEMORANDUM

To: **Holly Stallworth, Designated Federal Official**
Science Advisory Board Staff Office

From: Paul Gunning, Director
Climate Change Division

Subject: **Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources and Charge Questions for SAB peer review**

The purpose of this memorandum is to transmit the revised *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources,* related documentation and charge questions for consideration by the Science Advisory Board (SAB) during your upcoming peer review.

In January 2011, the U.S. Environmental Protection Agency (EPA) announced a series of steps it would take to address biogenic CO_2 emissions from stationary sources. EPA committed to conduct a detailed examination of the science and technical issues related to assessing biogenic CO_2 emissions from stationary sources and to develop a framework for evaluating those emissions. The draft study was released in September 2011 and subsequently peer reviewed by the SAB Ad-Hoc Panel on Biogenic Carbon Emissions (SAB Panel). The final peer review report was published September 2012.

To continue advancing the agency's technical understanding of the role that biomass use can play in reducing overall greenhouse gas emissions, the EPA released a second draft of the technical report, *Framework for Assessing Biogenic Carbon Dioxide for Stationary Sources*, in November 2014. This revised report presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions. The revised report takes into account the SAB Panel's peer review recommendations on the draft 2011 Framework as well as the latest information and input from the scientific community and other stakeholders.

The revised framework addressed many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis, including an alternative fate approach for waste-derived feedstocks and certain industrial processing products and byproducts; an evaluation of tradeoffs from using different temporal scales; an improved representation of the framework equation; and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales.

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We ask the SAB to review and offer recommendations on specific technical elements of the revised framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions, as identified in the charge accompanying this memo. We look forward to the SAB's review.

Please contact me if you have any questions about the attached study and charge.

Attachments:

1) *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*
2) Technical Appendices
3) Response to the 2011 SAB Panel Peer Review Advisory

Peer Review Charge on the Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

To improve the quality, utility, and scientific integrity of the Framework, EPA is providing this study, *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (November 2014) and related materials to the Science Advisory Board (SAB). The revised report takes into account the SAB Biogenic Carbon Emissions Panel's ("SAB Panel") peer review recommendations[2] on the draft 2011 Framework[3] as well as the latest information and input from the scientific community and other stakeholders. The "Response to SAB" document included in the materials provided for this review discusses and responds to the SAB Panel key points and recommendations, serving as a guide to how the revised framework incorporates their recommendations. This charge narrowly focuses on a few specific remaining questions that were not explicitly addressed in the initial SAB Panel peer review report.

The revised 2014 framework report identifies key scientific and technical factors associated with assessing biogenic CO_2 emissions from stationary sources using biogenic feedstocks, taking into account information about the carbon cycle. It also presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions.

The revised framework and the technical appendices address many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis (Appendices J-L); an alternative fate approach for waste-derived feedstocks (Appendix N); and certain industrial processing products and byproducts (Appendix D Addendum); an evaluation of tradeoffs from using different temporal scales (Appendix B); an improved representation of the framework equation (Appendix F); and illustrative case studies demonstrating how the framework equation can be applied, using region-

[2] The final peer review report from the SAB Panel on the draft 2011 framework was published on September 28, 2012 (Swackhamer and Khanna, 2011). Information about the SAB peer review process for the September 2011 draft framework is available at [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886"].

[3] The 2011 *Draft Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources* is available at [HYPERLINK "http://www.epa.gov/climatechange/ghgemissions/biogenic-emissions.html"].

feedstock combinations to generate regional defaults per different baseline approaches and temporal scales (Appendices H-N).

As explained in the revised framework introduction and accompanying SAB response document, the revised framework maintains the policy neutral approach from the 2011 draft Framework. It is a technical document that does not set regulatory policy nor does it provide a detailed discussion of specific policy and implementation options. Ultimately, the framework provides a methodological approach for considering, and a technical tool (the framework equation) for assessing, the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources. The revised framework details technical elements that should be considered as appropriate per specific policy applications or biogenic carbon-based feedstock assessments. Therefore, this charge excludes policy and regulatory recommendations or legal interpretation of the Clean Air Act's provisions related to stationary sources.

The revised report does not provide any final values or determinations: it offers indications of different biogenic feedstock production effects per research and analyses conducted, including illustrative example results per specific case study parameters. As discussed by the previous SAB Panel, this report also finds that biophysical and market differences between feedstocks may necessitate different technical approaches. Even using a future anticipated baseline approach, forest- and agriculture-derived feedstock characteristics, and thus analyses and results, may vary per region and per feedstock, and may be influenced by land use change effects. Illustrative analyses conducted for specific waste-derived feedstock case studies using a counterfactual anticipated baseline, as recommended by the SAB Panel, yielded minimal or negative net emissions effects.

This charge focuses on questions that remain regarding whether there are more definitive technical determinations appropriate for parameterizing key elements of the revised framework, regardless of application to a specific policy or program. Specifically, we ask that the SAB Panel examine and offer recommendations on future anticipated baseline specification issues in the context of assessing the extent to which the production, processing, and use of forest- and agriculture-derived biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions – such as appropriate temporal scales and the scale of biogenic feedstock usage (model perturbations or 'shocks') for analyzing future potential bioenergy production changes.

Technical approaches, merits and challenges with applying a future anticipated baseline

Establishing a baseline creates a point of comparison necessary for evaluating changes to a system.[4] Baseline specification can vary in terms of what entity or groups of entities are being analyzed (e.g., industries, economic sectors), temporal and spatial scales, geographic resolution, and, depending on context, environmental issues/attributes (EPA, 2010).[5] The choice of baseline approach can also depend

[4] Definitions for baseline vary, including "the reference for measurable quantities from which an alternative outcome can be measured" (IPCC AR4 WGIII, 2007) or "the baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines" (IPCC AR4 WGII, 2007).

[5] Guidelines for Preparing Economics Analyses (NCEE), Chapter 5: [HYPERLINK "http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-05.pdf/$file/EE-0568-05.pdf"]

on the question being asked and the goal of the analysis at hand. For example, some GHG analysis may require a baseline against which historic changes of landscape carbon stocks can be measured. Other applications may necessitate a baseline against which the estimated GHG emissions and sequestration associated with potential future changes in related commodity markets and policy arenas. Analyses of the estimated GHG emissions and sequestration effects from changes in biomass use have used different baseline approaches, as well as a wide range of different temporal scales and alternative scenario parameters (Sohngen and Sedjo, 2000; Fargione, 2008; UNFCCC, 2009; Walker et al., 2010; Cherubini et al, 2011; Galik and Abt, 2012; Latta et al., 2013; Walker et al., 2013; AEO, 2014; U.S. EPA, 2014; Miner et al., 2014).

The draft 2011 framework had discussed three different potential baseline approaches – reference point, future anticipated and comparative – and used the reference point baseline in its hypothetical case study applications of the Framework. The SAB Panel in its review stated that "the choice of a fixed reference point may be the simplest to execute, but it does not actually address the question of the extent to which forest stocks would have been growing/declining over time in the absence of a particular bioenergy facility" (SAB Advisory, p. 29). The SAB Panel expressed concern that the reference point baseline does not address the important question of additionality, or what would have been the trajectory of biogenic CO_2 stocks and fluxes in the absence of an activity or activities using biogenic feedstocks for energy, especially in the context of forest-derived feedstocks.[6] "Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach" (SAB Letter, p. 2).

Through public comments to the SAB Panel during the 2011-2012 SAB peer review process, various stakeholders expressed divergent perspectives on the appropriate baseline for the draft 2011 framework report.[7] The revised 2014 framework retains the reference point baseline and adds the anticipated baseline in order to retain adaptability for potential applications, and discusses both approaches at length in the revised report and several technical appendices. However, as the SAB Panel was clear in its previous review of the reference point baseline, EPA has no outstanding technical questions for the SAB Panel on that baseline approach. This charge focuses specifically on remaining technical questions that EPA has on the future anticipated baseline approach.

Part 1 – Future anticipated baseline approach and temporal scale

[6] The difference in net atmospheric CO_2 emissions contributions with and without changes in biogenic feedstock use is known as additionality (Murray et al., 2007). Additionality can be determined by assessing the difference in potential net atmospheric CO_2 emissions of a specific level of biogenic feedstock use over a certain period of time (in many cases the business-as-usual [BAU] baseline) versus the net atmospheric CO_2 emissions contributions that would have occurred over the same time period with a different level of biogenic feedstock use (counterfactual scenario), holding other factors and assumptions consistent between scenarios.

[7] The American Forest and Paper Association (AF&PA) supported the reference point baseline (e.g., comments submitted October 2011, March 2012) applied historically (January 2012, March 2012). The National Alliance of Forest Owners (NAFO) stated if certain feedstocks weren't categorically excluded, then the historical reference point baseline should be used (e.g., March 2012, August 2012). The U.S. Department of Agriculture stated preference for a historic baseline approach (May 2012). The Environmental Defense Fund (EDF) (January 2012, May 2012) and NCASI (October 2011, March 2012) both supported the retrospective reference point approach, though also both offered recommendations if an anticipated baseline approach was included (EDF for future anticipated and NCASI for counterfactual). Others, such as Green Power Institute (March 2012), the National Resource Defense Council (NRDC, August 2012), Becker et al. (August 2012), Biomass Energy Resource Center et al. (February 2012), and a group scientists letter to EPA (June 2014) all support some form of the anticipated baseline approach (future anticipated and/or counterfactual).

It is important to consider possible treatments of time and the implications of these treatments in developing strategies for long-term and short-term emissions assessment, because the choice of treatment may have significant impacts on the resultof an assessment framework application. For the intended use of the revised Framework – assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions – there are different elements of time to consider when using a future anticipated baseline approach. These elements can include:

- Emissions horizons, assessment or policy horizons, and reporting periods (i.e., fluxes related to feedstock production may occur over many years to decades, whereas reporting may be the current year and policies may cover only a few years or decades), and
- Differences in temporal characteristics of different feedstocks (i.e., annual crops, short rotation energy crops, and longer rotation forestry systems).
- Changes in biophysical and economic conditions over time may affect or differ from those in future anticipated baseline and scenario estimates.

The SAB Panel in its previous peer review noted that "this is a complicated subject because there are many different time scales that are important for the issues associated with biogenic carbon emissions" (Advisory, page 13). They discussed multiple temporal scales associated with mixing of carbon throughout the different reservoirs on the Earth's surface at the global scale (Advisory, page 13) and climate responses to CO_2 and other greenhouse gases (Advisory, page 15), implications of temporal scales greater and shorter than 100 years, and those related to the growth cycles of different feedstock types (Advisory, page 15). The SAB Panel specifically highlighted considerations for using a 100-year or longer temporal scale for evaluating climate impacts and radiative forcing[8] as well as decay rates and carbon storage in forest ecosystems in the main text as well as in Appendices B-D. However, in its recommendations, including those for developing default BAFs per region, the SAB Panel did not offer recommendations per what temporal scale to use in the specific context of the Framework for its intended use and scope. Instead, the SAB Panel stated that "there is no scientifically correct answer when choosing a time horizon, although the *Framework* should be clear about what time horizon it uses, and what that choice means in terms of valuing long term versus shorter term climate impacts (Advisory, page 15) and recommended that a revised framework "incorporate various time scales and consider the tradeoffs in choosing between different time scales" (Advisory, page 43).

Multiple stakeholders have also weighed in on temporal scales, some with specific recommendations on what temporal scale should/could be used for framework assessments, others with no specific recommendations but emphasizing the importance of time. In various comments submitted during the 2011-2012 SAB process, NAFO supported a 100-year timeframe (March 2012). The National Council for Air and Stream Improvement (NCASI) in October 2011 comments suggested "the need for

[8] EPA acknowledges that the long-term climate impacts of shifting from fossil fuel to biogenic energy sources is an important topic for climate change mitigation policy and also recognizes the extensive work being conducted by EPA and throughout the research community on this question. However, EPA's focus here is on a narrower, more targeted goal of developing tools to assess the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic feedstocks at stationary sources. This more narrowly defined assessment is anticipated to be a better fit for the types of program and policy applications in which this framework may potentially be applied.

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considerable flexibility in setting the temporal scales for determining the stability of forest carbon stocks. There are a range of circumstances that can cause transient trends in carbon stocks that can obscure the more relevant long-term picture."

Other groups, such as The Wilderness Society (TWS), NRDC, EDF and others, submitted comments supporting consideration of shorter temporal scales. In its comments and example calculations, TWS (in October 2011 comments) implied support for shorter temporal scales, and stated in later comments that the SAB "text appears biased toward ignoring effects that occur within a 100-year period" (May 2012). NRDC (August 2014) implied support for shorter temporal scales: "even if near-term carbon emissions increases are eventually 'made up' by regrowth over the very long term, the carbon emission from these types of biomass actually exceed those from fossil fuels for decades. This puts use of these types of biomass fuels in conflict with the urgent need for near-term carbon emissions reductions. The time profile of the carbon emission from biogenic fuel sources matters because it is critical to limit near-term global GHG emissions." This perspective was similar to that shared by Becker et al. in their August 2012 comments. EDF (January 2012) suggested a very short temporal scale (in the context of supporting a retrospective reference baseline). Others, such as the Biotechnology Industry Organization (October 2011) simply asked for "clarification on the methodology used to identify the time scale of carbon cycles."

Per the various recommendations above, the revised framework report and the technical appendices include a more detailed discussion of intertemporal tradeoffs inherent in various options for treating emissions over time in the context of assessing biogenic CO_2 emissions from stationary sources. Specifically, the revised report has: a section on key temporal scale considerations (pages 33-38); an appendix dedicated to temporal scale issues (Appendix B), which includes further discussion of temporal scales in the context of future anticipated baselines and decay rates for feedstocks that would have otherwise decayed if not used for energy, and; an appendix describing the background of and modeling considerations for constructing an anticipated baseline approach (Appendix J). Also, illustrative calculations using the future anticipated baseline estimates use future simulations and thereby explicitly incorporate temporal patterns of different feedstocks (e.g., feedstock growth rates, decay rates) into the analysis and shows how results can vary per temporal scale used (as seen in Appendices K and L). The revised framework does not recommend specific temporal scales for framework applications, but rather identifies different elements of and considerations concerning time to provide insights into the potential implications of using different temporal scales.

EPA seeks guidance on the following issues regarding appropriate temporal scales for assessing biogenic CO_2 emissions using a future anticipated baseline, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the previous SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of temporal scale both within and outside of a specific policy context.

Part 1 – Future anticipated baseline approach and temporal scale

1. What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of

biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

a. Should the temporal scale for computing BAFs vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.
    i. If temporal scales for computing BAFs vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?
    ii. Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?
    iii. Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default BAFs versus crafting policy specific BAFs?
b. Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?
c. Should calculation of the BAF include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?
d. What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions *ex post*), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

Part 2 – Scales of biomass use when applying future anticipated baseline approach

EPA seeks guidance on technical considerations concerning how to select model perturbations ('shocks') for future anticipated baseline simulations estimating the net atmospheric contribution of biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework

could be also be used in specific policy contexts, the questions below relate to the choice of model shocks both within and outside of a specific policy context.

2. What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?
   a. Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
   b. What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?
   c. Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?
   d. Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?
   e. For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).
   f. How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?
   g. Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?
   h. What considerations could be useful when evaluating the performance of the demand shock choice *ex post*, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward

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APPENDIX B: MEMBERS OF THE BIOGENIC CARBON EMISSIONS PANEL

CHAIR

Dr. Madhu Khanna, ACES Distinguished Professor in Environmental Economics, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Urbana, IL

PANEL MEMBERS

Dr. Robert Abt, Professor of Forestry, Department of Forestry and Environmental Resources, College of Natural Resources, North Carolina State University, Raleigh, NC

Dr. Morton Barlaz, Professor, Civil, Construction, and Environmental Engineering, Engineering, North Carolina State University, Raleigh, NC

Dr. Marilyn Buford, National Program Leader, Silviculture Research, Research & Development, USDA Forest Service, Washington, DC

Dr. Mark Harmon, Professor and Richardson Chair, College of Forestry, Oregon State University, Corvallis, OR

Dr. Jason Hill, Associate Professor, Bioproducts and Biosystems Engineering, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota, St. Paul, MN

Dr. John Reilly, Senior Lecturer and Co-Director, Joint Program on the Science and Policy of Global Change, Center for Environmental Policy Research, E19-439L, Massachusetts Institute of Technology, Cambridge, MA

Dr. Charles Rice, Distinguished Professor, Department of Agronomy, Soil Microbiology, Kansas State University, Manhattan, KS

Dr. Steven Rose, Senior Research Economist, Energy and Environmental Analysis Research Group, Electric Power Research Institute, Palo Alto, CA

Dr. Daniel Schrag, Professor of Earth and Planetary Sciences, Harvard University, Cambridge, MA

Dr. Roger Sedjo, Senior Fellow and Director of the Center for Forest Economics and Policy Program, Resources for the Future, Washington, DC

Dr. Ken Skog, Supervisory Research Forester (retired), Economics and Statistics Research, Forest Products Laboratory, USDA Forest Service, Madison, WI

Dr. Tristram West, Ecosystem Scientist, Joint Global Change Research Institute, University of Maryland, College Park, MD

Dr. Peter Woodbury, Senior Research Associate, Department of Crop and Soil Sciences, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, U.S.A.

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SCIENCE ADVISORY BOARD STAFF

Dr. Holly Stallworth, Designated Federal Officer, U.S. Environmental Protection Agency, Washington, DC

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Message

From: Steven Hamburg [shamburg@edf.org]
Sent: 9/25/2018 10:02:18 PM
To: Jeanne VanBriesen [jeanne@cmu.edu]; Michael Honeycutt [Michael.honeycutt@tceq.texas.gov]; Carpenter, Thomas [Carpenter.Thomas@epa.gov]; William Schlesinger [schlesingerw@caryinstitute.org]
CC: Brennan, Thomas [Brennan.Thomas@epa.gov]
Subject: RE: Public comments as of 9/24 12:20 9/24
Attachments: Mikes Intro. JV comments sph.docx

Mike

Attached are your comments with a few additional suggested edits. One change I would strongly recommend is referring to the biogenic subcommittee as a subcommittee of the SAB at all times – suggested edits along those lines. We need to help push back on the narrative that they had an existence outside of advising the SAB. They went on for so long they saw themselves as a standing committee – rather than an *ad hoc* subcommittee advising the SAB – not reporting directly to the EPA.

Cheers
Steve

From: Jeanne VanBriesen <jeanne@cmu.edu>
Sent: September 25, 2018 4:10 PM
To: Michael Honeycutt <Michael.Honeycutt@tceq.texas.gov>; Carpenter, Thomas <Carpenter.Thomas@epa.gov>; William Schlesinger <schlesingerw@caryinstitute.org>; Steven Hamburg <shamburg@edf.org>
Cc: Brennan, Thomas <Brennan.Thomas@epa.gov>
Subject: RE: Public comments as of 9/24 12:20 9/24

Hi Mike:

I like the context setting in this paragraph, and I agree it is important to have this for the members who have not been on the SAB through the long process with this task.

I made some suggestions in the attached.

jeanne

From: Michael Honeycutt <Michael.Honeycutt@tceq.texas.gov>
Sent: Monday, September 24, 2018 3:17 PM
To: Carpenter, Thomas <Carpenter.Thomas@epa.gov>; William Schlesinger <schlesingerw@caryinstitute.org>; Jeanne VanBriesen <jeanne@cmu.edu>; Steven Hamburg <shamburg@edf.org>
Cc: Brennan, Thomas <Brennan.Thomas@epa.gov>
Subject: RE: Public comments as of 9/24 12:20 9/24

This needs help, but it's a start. I think it captures most of what we talked about today. Plus, I want to give the newer Board members some sort of context. Please edit at will.

Thanks,
Mike

The next agenda item is the Quality Review of the draft SAB Review of EPA's Framework for Assessing Biogenic CO2 Emissions from Stationary Sources. Today will hopefully mark the end of a long journey for this review. EPA originally developed a framework for estimating biogenic CO2 emissions in 2011 that was reviewed by the Biogenic Carbon Emissions Panel and the SAB in 2012. EPA subsequently revised the framework and re-issued it in 2014. The Biogenic Carbon Emissions Panel was reconstituted and met multiple times between March 2015 and August 2017. I'm sure I also speak for EPA when I thank the Biogenic Carbon Emissions Panel on behalf of the SAB for their hard work and dedication to their tasks. The Panel presented a draft report in February 2016 to the SAB for quality review. The SAB quality review was conducted in March 2016; where the Board asked the Panel for more revisions. The revised draft report of June 2017 was reviewed by the Board in August 2017. The 2017 revision of the report was not approved by the SAB based on the deliberations of the quality review. Speaking broadly and in simple, general terms, there were two primary areas of contention the SAB had over the report. One was the time frame over which the carbon emissions should be accounted for. The Panel thought the time frame should be determined by physical inputs, like, for example, reforestation rates, while the Board thought the accounting time frame should be able to be determined by policy. For example, if EPA promulgates a rule that has to be implemented by 2050, the Board thought it was important to be able to account for CO2 emissions for the time period specified by a regulation. The second general area of contention was in the model itself. The model the Panel advocated for is more complex and detailed, requiring specific expertise to operate. The model the Board advocates for is less complex, and able to be operated by people with less specific expertise. At the August 2017 meeting, the SAB seriously considered abandoning the project altogether, but ultimately voted to continue with the project. This report is a product of SAB's direct efforts and utilizes portions of the Panel's report. I want to note that this entire deliberative process that began in 2011 has followed the SAB's processes and charter, as well as Federal Advisory Committee Act procedures. All SAB deliberations have been made in the public's eye, with public input. Every step of this process can be followed by visiting the SAB website.

Independent of this review process, this past April, EPA issued a policy statement stating the agency will treat biogenic CO2 emissions resulting from the combustion of biomass from managed forests at stationary sources for energy production as carbon neutral. The charge to the SAB to comment on the science underpinning EPA's Biogenic Carbon Emissions Framework is not changed by the policy statement from the Agency. As science advisors to the Agency, we undertake this review to provide our expert advice. This afternoon, we'll first hear public comments from the registered speakers. I also want to thank those that provided written comments. We have three sets of written comments from members of the Biogenic CO2 panel – one letter signed by four members, and two individual sets of written comments from two different panel members. Plus, we have written comments from various industry and environmental groups. After we hear oral comments from the registered speakers, Drs. Steve Hamburg, Bill Schlesinger, and Jeanne VanBriesen will give an overview of the report. Then, we'll hear from the lead reviewers, Dr. Rodney Andrews, Dr. Larry Monroe, and Dr. Surabi Menon. Afterwards, the full SAB will have a discussion and decide the disposition of the report. The first public commenter is XXX.

Michael Honeycutt, Ph.D.
Director, Toxicology Division
Texas Commission on Environmental Quality

Phone: (512)239-1793
Mobile: (512)623-0916
E-Mail: michael.honeycutt@tceq.texas.gov

From: Carpenter, Thomas <Carpenter.Thomas@epa.gov>
Sent: Monday, September 24, 2018 11:27 AM
To: William Schlesinger <schlesingerw@caryinstitute.org>; jeanne@cmu.edu; Steven Hamburg <shamburg@edf.org>;

Michael Honeycutt <Michael.Honeycutt@tceq.texas.gov>
Cc: mwelch@edf.org; Brennan, Thomas <Brennan.Thomas@epa.gov>
Subject: Public comments as of 9/24 12:20 9/24

Attached are the public comments.

Surabi's comments for QR were the only new SAB comments they are also attached for your convenience.

I will send a new SAB members logistics memo email at the end of the day.

Tom

-----Original Appointment-----
From: Carpenter, Thomas
Sent: Monday, September 24, 2018 12:05 PM
To: Carpenter, Thomas; Schlesinger William (schlesingerw@caryinstitute.org); jeanne@cmu.edu; Steven Hamburg; Michael Honeycutt (Michael.honeycutt@tceq.texas.gov)
Cc: mwelch@edf.org
Subject: prep for teleconference
When: Wednesday, September 26, 2018 10:00 AM-10:30 AM (UTC-05:00) Eastern Time (US & Canada).
Where: teleconference

1-866-299-3188
202 564 4885#

Matt, Steve agreed to this time – please accept.

This e-mail and any attachments may contain confidential and privileged information. If you are not the intended recipient, please notify the sender immediately by return e-mail, delete this e-mail and destroy any copies. Any dissemination or use of this information by a person other than the intended recipient is unauthorized and may be illegal.

The next agenda item is the Quality Review of the draft SAB Review of EPA's Framework for Assessing Biogenic CO2 Emissions from Stationary Sources. Today will hopefully mark the end of a long journey for this review. EPA originally developed a framework for estimating biogenic CO2 emissions in 2011 that was reviewed by a subcommittee of the SAB established for that purpose - ~~the~~ Biogenic Carbon Emissions subcommittee ~~Panel~~ and the SAB in 2012. EPA subsequently revised the framework and re-issued it in 2014. The SAB subcommittee ~~Biogenic Carbon Emissions Panel~~ was reconstituted and met multiple times between March 2015 and August 2017. I'm sure I also speak for EPA when I thank the Biogenic Carbon Emissions SAB subcommittee~~Panel~~ on behalf of the SAB for their hard work and dedication to their tasks.

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At the August 2017 meeting, with significant remaining differences between the subcommittee~~Panel~~ and the SAB, the SAB~~the SAB seriously~~ voted to not~~considered~~ abandon~~ing the project altogether~~efforts to respond to EPA's request for guidance on biogenic carbon accounting. Ultimately, the SAB~~, but ultimately~~ voted to continue with the project by tasking the lead reviewers from within the~~a group of SAB members~~ to integrate portions of the Panel's report with information from the SAB reviews. The report we are considering today ~~is report~~ is a product of SAB's direct efforts and utilizes portions of the Panel's report. I want to note that this entire deliberative process that began in 2011 has followed the SAB's processes and charter, as well as Federal Advisory Committee Act procedures. All SAB deliberations have been made in the public's eye, with public input. Every step of this process can be followed by visiting the SAB website.

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individual sets of written comments from two different panel members. Plus, we have written comments from various industry and environmental groups. After we hear oral comments from the registered speakers, Drs. Steve Hamburg, Dr. Bill Schlesinger, and Dr. Jeanne VanBriesen will give an overview of the report. Then, we'll hear from the lead reviewers, Dr. Rodney Andrews, Dr. Larry Monroe, and Dr. Surabi Menon. Afterwards, the full SAB will have a discussion and decide the disposition of the report. The first public commenter is XXX.

Message

From: Steven Hamburg [shamburg@edf.org]
Sent: 9/25/2018 9:56:31 PM
To: Jeanne VanBriesen [jeanne@cmu.edu]; Michael Honeycutt [Michael.honeycutt@tceq.texas.gov]; Carpenter, Thomas [Carpenter.Thomas@epa.gov]; William Schlesinger [schlesingerw@caryinstitute.org]
CC: Brennan, Thomas [Brennan.Thomas@epa.gov]
Subject: RE: Public comments as of 9/24 12:20 9/24

Jeanne

Thanks – I am working my way through all of the comments – largely there. Overall there are uniform comments that this is better than its predecessor – will quote a few people who say this and come from very different positions. I have found no show stoppers and quite the contrary most issues are bookended – people pushing in opposite directions. I did find some very helpful comments relative to making the report more direct and cleaning up inconsistencies. I also found the two sets of comments for subcommittee members separate from those of Kanna et al, very supportive and a counter weight to what she had to say.

Will try to get my outline out asap – sorry it has gotten so last minute.

Steve

From: Jeanne VanBriesen <jeanne@cmu.edu>
Sent: September 25, 2018 1:58 PM
To: Michael Honeycutt <Michael.Honeycutt@tceq.texas.gov>; Carpenter, Thomas <Carpenter.Thomas@epa.gov>; William Schlesinger <schlesingerw@caryinstitute.org>; Steven Hamburg <shamburg@edf.org>
Cc: Brennan, Thomas <Brennan.Thomas@epa.gov>
Subject: RE: Public comments as of 9/24 12:20 9/24

Hi Mike, Bill, Steve, Tom and Tom:

I have now made it through all the materials in prep for tomorrow's call.

I've drafted remarks relevant to the modeling issues, focusing on the dependence of BAF on the model and the dependence of the model on the policy choice. I ended with a few brief remarks about issues raised by reviewers and written commenters. I welcome your thoughts on these (attached). Since these will follow Steve's remarks (and come either before or after Bill's – I can't remember), it would be great to know how they align with your thinking.

While this modeling point summary does not explicitly deal with issues of the baseline (reference point, anticipated, or regularly updated reference point), use of a model like FASOM would require the baseline conditions as input. And, the anticipated baseline approach requires a model to construct the counter-factual scenario.

To ensure we present a consistent description of the interactions of these two components (the model and the baseline), it would be good for us to chat tomorrow about the response to issues raised by commenters about the baseline.

Thanks,

jeanne

From: Michael Honeycutt <Michael.Honeycutt@tceq.texas.gov>
Sent: Monday, September 24, 2018 3:17 PM
To: Carpenter, Thomas <Carpenter.Thomas@epa.gov>; William Schlesinger <schlesingerw@caryinstitute.org>; Jeanne VanBriesen <jeanne@cmu.edu>; Steven Hamburg <shamburg@edf.org>
Cc: Brennan, Thomas <Brennan.Thomas@epa.gov>
Subject: RE: Public comments as of 9/24 12:20 9/24

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Mike

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Texas Commission on Environmental Quality

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E-Mail: michael.honeycutt@tceq.texas.gov

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Where: teleconference

1-866-299-3188
202 564 4885#

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Message

From: Jeanne VanBriesen [jeanne@cmu.edu]
Sent: 9/25/2018 8:10:19 PM
To: Michael Honeycutt [Michael.honeycutt@tceq.texas.gov]; Carpenter, Thomas [Carpenter.Thomas@epa.gov]; William Schlesinger [schlesingerw@caryinstitute.org]; Steven Hamburg [shamburg@edf.org]
CC: Brennan, Thomas [Brennan.Thomas@epa.gov]
Subject: RE: Public comments as of 9/24 12:20 9/24
Attachments: Mikes Intro. JV comments.docx

Hi Mike:

I like the context setting in this paragraph, and I agree it is important to have this for the members who have not been on the SAB through the long process with this task.

I made some suggestions in the attached.

jeanne

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Message

From: Carpenter, Thomas [Carpenter.Thomas@epa.gov]
Sent: 9/18/2018 2:50:01 PM
To: Genna Reed [GReed@ucsusa.org]
Subject: RE: Public comment at SAB 9/26 meeting
Attachments: Agenda sep 26 telecon.pdf

Hello,
I can accommodate noting your colleague may speak for you. Which topic will you be providing public comment? The review of the IRIS assessments or the review of the biogenic carbon dioxide emissions framework?

I attached a copy of the agenda that is being posted on the web page as we email.
Regards,
Tom

Thomas Carpenter
Designated Federal Officer / Sr. Biologist
US EPA Science Advisory Board, MC 1400R
1200 Pennsylvania Avenue, NW
Washington DC 20460
ph 202 564 4885 Fax 202 565 2098

From: Genna Reed [mailto:GReed@ucsusa.org]
Sent: Tuesday, September 18, 2018 10:43 AM
To: Carpenter, Thomas <Carpenter.Thomas@epa.gov>
Subject: Public comment at SAB 9/26 meeting

Hi Tom,

Hope all is well with you! I am interested in signing myself up for an oral statement on the SAB's teleconference on 9/26 however I am pregnant and my due date is 9/25, so would it be possible to also put the name of my colleague, Michael Halpern, on the list just in case I'm not able to be on the call?

Also I know the agenda hasn't yet been posted but do you have a sense of what time the public comment section will be?

Thanks so much!

Genna Reed
Lead Science & Policy Analyst, Center for Science and Democracy
she / her / hers

Union of Concerned Scientists | 1825 K Street NW, Suite 800 | Washington, D.C. 20006
Phone: 202-331-6940 | Email: GReed@ucsusa.org

The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with people across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

www.ucsusa.org | Join our action network or expert network | Support our work.
Follow my blog or find me on twitter at @gennareed or follow UCS on Facebook, Twitter, and LinkedIn.

Message

From: Jeanne VanBriesen [jeanne@cmu.edu]
Sent: 9/25/2018 5:57:54 PM
To: Michael Honeycutt [Michael.honeycutt@tceq.texas.gov]; Carpenter, Thomas [Carpenter.Thomas@epa.gov]; William Schlesinger [schlesingerw@caryinstitute.org]; Steven Hamburg [shamburg@edf.org]
CC: Brennan, Thomas [Brennan.Thomas@epa.gov]
Subject: RE: Public comments as of 9/24 12:20 9/24
Attachments: VanBriesen Oral Comments SAB Meeting 9.26.2018.docx

Hi Mike, Bill, Steve, Tom and Tom:

I have now made it through all the materials in prep for tomorrow's call.

I've drafted remarks relevant to the modeling issues, focusing on the dependence of BAF on the model and the dependence of the model on the policy choice. I ended with a few brief remarks about issues raised by reviewers and written commenters. I welcome your thoughts on these (attached). Since these will follow Steve's remarks (and come either before or after Bill's – I can't remember), it would be great to know how they align with your thinking.

While this modeling point summary does not explicitly deal with issues of the baseline (reference point, anticipated, or regularly updated reference point), use of a model like FASOM would require the baseline conditions as input. And, the anticipated baseline approach requires a model to construct the counter-factual scenario.

To ensure we present a consistent description of the interactions of these two components (the model and the baseline), it would be good for us to chat tomorrow about the response to issues raised by commenters about the baseline.

Thanks,

jeanne

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Oral Remarks Lead Authors: Modeling Component. SAB Meeting 9/25/2018. VanBriesen

An important component of the review of the EPA Framework was adequately presenting the challenge in addressing biogenic carbon feedstocks and associated emissions with an accounting term or construct – the biogenic assessment factor (BAF). While much is known about biogenic carbon cycling on the planet, the EPA framework was not focused on that science, but rather on creating a structure to define the BAF term in a consistent manner across multiple possible policy objectives. BAF was to represent an adjustment to be made to CO2 emissions based on *expectations* about the role of carbon cycling in mediating the effect of those emissions on climate and associated climate-outcomes (e.g., global temperature, sea-level rise) as well as other direct CO2 effects (e.g. ocean acidification). The future state associated *expectations* were based not only on scientific understanding of the biogeochemical and physical changes that would occur, but also based on understanding of the choices involved in economic markets associated with biogenic feedstocks.

Since the BAF depends upon those expectations of the future state of carbon related to biogenic feedstocks (including regrowth, soil carbon sequestration, etc.) models to simulate the future or to project future states underlie the BAF calculation. These models played a critical role in EPA's framework as well as in SAB's analysis of that framework. This type of coupled ecological and economic model is very challenging to develop, parameterize, and validate. Further, assumptions about past conditions can strongly affect model results, and model parameterization requires data that maybe difficult to acquire at spatial or temporal resolutions necessary, which can lead to additional assumptions.

An important characteristic of the models EPA suggested in the Framework is that they are designed to simulate possible futures under specific assumptions. In the case of models for biogenic carbon feedstocks and emissions, these assumptions **include policy choices**. The primary model EPA suggested using for BAF is called FASOM (Forest and Agricultural Sector Optimization Model). It is an economic simulation tool used to **evaluate the potential implications of proposed policy designs** and alternative future economic, biophysical, and climatic conditions on the US forestry and agriculture sectors, land use, and GHG emissions. The model is explicitly NOT intended for prediction, but rather for simulation or projection of responses to **policy change**. Thus, the intended use of this model requires a policy as input to its simulations. Further, EPA's own review of this model highlighted concerns with its transparency and the difficulty in considering sensitivity analysis for critical parameters & assumptions.

We recommend in this report that EPA revise the framework to be more specific, including proposed policies, defined scenarios, and their justification. Because of the transparency challenges associated with models like FASOM, we also recommend EPA adopt models where the underlying assumptions are clearly described and the implications of those assumptions for the computed BAFs can be more readily assessed – in other words, where uncertainty and sensitivity analyses can be included with results. For whatever model EPA chooses, we further recommend identification and evaluation of criteria for model selection and examination of sensitivity of computed BAF values to key modeling features (e.g., input parameters, assumptions, etc.).

Several SAB members (and at least one public commenter) remarked that we need to avoid generalizations about the simplicity or complexity of models for this type of application. We agree and will revise to reflect this. There were also concerns raised about discussion of uncertainty within models and the differences between ecological and economic models. We agree these are important points, and we'll improve the clarity in the report regarding these issues.

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Attachments: Chronology Biogenic Carbon EmissionsReport.docx

Add this as the last sentence to the first paragraph.
'The SAB staff office posted a chronology with links to the mile stones I mentioned on the web page for today's meeting."

The Chronology is attached. Its factual and dry. I will post I tomorrow morning.

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Chronology of SAB activities and advice regarding Biogenic Carbon Emissions from Stationary Sources

In 2011, EPA developed a draft document, Accounting Framework for Biogenic CO2 Emissions from Stationary Sources (September 2011). The context for the Framework arose when the EPA established thresholds for greenhouse gas emissions from stationary sources for the purposes of Clean Air Act permits under the New Source Review (Prevention of Significant Deterioration program) and Title V operations program. The agency needed to consider how to include biogenic emissions in determining whether thresholds for regulation have been met. In July 2011, the EPA deferred the application of permitting requirements to biogenic carbon dioxide emissions from bioenergy and other biogenic stationary sources for three years, while conducting a detailed examination of the issues associated with biogenic CO2. To explore the scientific and technical issues associated with accounting for emissions of biogenic carbon dioxide (CO2) from stationary sources and to develop a method to adjust the stack emissions from bioenergy based on the induced changes in carbon stocks on land (in soils, plants and forests). The [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/02ad90b136fc21ef85256eba00436459/2f9b572c712ac52e8525783100704886!OpenDocument"] the draft framework (see report [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf"]) and identified a number of limitations and implementation challenges.

The agency subsequently revised the 2011 framework report and has asked the SAB to review of the revised technical report. The agency submitted a second report for the SAB to review in 2014 [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/02ad90b136fc21ef85256eba00436459/3235DAC747C16FE985257DA90053F252/$File/Framework-for-Assessing-Biogenic-CO2-Emissions+(Nov+2014).pdf"]. (PDF, 69 pp., 2,233,864 bytes). In February of 2015, the SAB created an [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252/$File/Det.%20Memo%20Biogenic%20Carbon%20Merged%202011%20and%202015%20files.pdf"] that participated in the previous review. The activities of the Biogenic Carbon Emissions Panel are posted on the SAB webpage under the [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252?OpenDocument"].

Quality Reviews

The Biogenic Carbon Emissions Panel submitted a draft report for quality review at a [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/1A5A2FD1C8FCE7C585257F390054FD5C?OpenDocument"]. The SAB discussed the [HYPERLINK "file:///C:\\Users\\tcarpent\\Documents\\Carpenter%20Data%20files\\SAB\\Biogenic%20CO2%20Emission%20Revision\\Draft%20(2-8-2016)%20SAB%20Review%20of%20Framework%20for%20Assessing%20Biogenic%20CO2%20Emissions%20from%20Stationary%20Sources%20(2014)"] during [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/Serving%20on%20the%20EPA%20Science%20Advisory%20Board:%20A%20Handbook%20for%20Members%20and%20Consultants/$File/Serving%20on%20the%20EPA%20Science%20Advisory%20Board%20SABSO-12-

001.pdfhttps:/yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/Serving%20on%20the%20EPA%20Science%20Advisory%20Board:%20A%20Handbook%20for%20Members%20and%20Consultants/$File/Serving%20on%20the%20EPA%20Science%20Advisory%20Board%20SABSO-12-001.pdf"]. The SAB voted to return the report back to the panel with a [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/DFFA28788A0FDF9D8525818400780D0D/$File/84147998.pdf"]to be addressed. In May 2016, SAB members worked with the Chair of the Biogenic Carbon Emissions Panel and scheduled an [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/BD5980491F4F4FBB85257FEF0048CBC4?OpenDocument"] with panel members to address the SAB direction from the Quality Review of March 2016.

The Biogenic Carbon Emissions Panel provided an [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/0DEC3A886417946D852581840077F025/$File/19403358.pdf"] of revisions and a [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/ea5d9a9b55cc319285256cbd005a472e/6cc0c0fa87b00f72852581860059a5eb/$FILE/BiogenicCarbon-06-02-17.pdf"] in June of 2017 for a second quality review. The SAB conducted that quality review at an [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/128C37947B204E7785258154007916 0E?OpenDocument"]. The revisions did not address the SAB comments on time frame and presented a single recommendation rather than expanding the discussion to identify the range of potential policy frameworks. The Chair of the SAB worked with SAB members and the panel members to provide additional revisions to the sections of the June Draft (the [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/9E95C283C10E110885258184007815B4/$File/40026578.pdf"] and the [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/FC1953A2C229AC7D8525818400781CBB/$File/70217375.pdf"]) to facilitate the second quality review discussion. The additional revisions and [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/D0469338D5F4782685258312007155 05/$File/Instructions+for+the+Biogenic+Carbon+Emissions+Report+Discussion_Redacted.pdf"] of the SAB were sent in an email to SAB members.

The SAB discussed the revisions and found they did not address all the requests the SAB requested in the March 2016 quality review. They discussed possible revisions, implications of not completing the report, and exercising a pocket veto. A motion was made to not complete the report and seconded but failed overwhelmingly. Another motion was made for lead quality reviewers to revise the report to reflect the SAB discussions, acknowledge and describe the complexity of the subject matter in the report, and use portions of the panel draft report to develop a revision for the SAB's review. This motion passed by voice vote. The result of the August 2017 review was lead SAB reviewers and the members were to be charged with that task.

The Next Steps

The SAB was briefed in May 2018 regarding old business in a preparatory meeting. The Board agreed to review a revised report during a third quality review at an upcoming meeting. The draft panel report will remain on the SAB web pages to document the Biogenic Carbon Emission Panel's work.

- A group of SAB members will revise the June 2017 report based on the SAB discussions, using sections of the June 2017 draft and add information to the report to improve the clarity,

identify major issues, and explain the complexity of accounting for biogenic carbon emissions.

- Suggested members to revise the report should be the lead reviewers from previous reviews and members with expertise. Drs. Steve Hamburg, Surabi Menon, Bill Schlesinger and Jeanne VanBriesen were asked to participate.
- The SAB members will work toward a draft being ready for the SAB by August 2018.

- The SAB would conduct a quality review to finalize the report in late summer report selecting new quality review leads from the SAB members.

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DATE

EPA-SAB-19-xxx

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Subject: SAB review of *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014)

Dear Acting Administrator Wheeler:

The EPA Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014) ("2014 Framework"). The 2014 Framework considers the scientific and technical issues associated with accounting for emissions of carbon dioxide (CO_2) from biogenic feedstocks used at stationary sources.

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for CO_2 emissions associated with the combustion of biogenic feedstocks at stationary facilities by accounting for the biological carbon cycle effects associated with growth, harvest, and processing of these feedstocks. The BAF is an accounting term developed by EPA to adjust stack emissions to reflect a feedstock's *net* carbon emissions after accounting for subsequent sequestration of carbon in regrown biomass or soil, and after considering emissions that might have occurred with an alternate fate had the biomass not been used for fuel.

The SAB notes that EPA's 2014 Framework may be used to develop BAFs for multiple regulations and associated climate objectives (e.g., total emissions versus temperature, etc.); it therefore must be able to accommodate a wide range of potential time and spatial scales and all relevant GHGs. Lack of specificity in the BAF objectives to be addressed under the Framework has made it difficult for the SAB to address many of the charge questions fully.

EPA's 2014 Framework is a revision of its 2011 Framework, which the SAB previously reviewed. The SAB notes that the 2014 Framework incorporated some of the SAB's prior advice and advanced the analytical foundation for making determinations about the net contribution of biogenic feedstocks to CO_2 in the atmosphere. Specifically, the 2014 Framework has incorporated the SAB's prior advice as follows:

- It has adopted an alternative fate approach (i.e., a counterfactual evaluation of what the net biogenic atmospheric contribution might have been if the feedstocks were not used for energy) to the collection and use of waste-derived feedstocks, including avoided methane (CH_4) emissions.

- It includes a discussion of the trade-offs inherent in the selection of a temporal scale for considering net emissions.
- It has developed representative BAFs by feedstock and region rather than facility-specific BAFs.
- It includes a review of existing approaches to addressing leakage, the phenomenon by which efforts to reduce emissions in one place affect market prices that shift emissions to another location.
- It offers an approach to construct an anticipated baseline that allows assessment of the additional CO_2 emissions to, or uptake from, the atmosphere that can be attributed to biogenic feedstocks as a result of changes in biomass feedstock demand.

The 2014 Framework does not, however, provide the regulatory context, specific BAF calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. The BAF is a *construct* designed to evaluate the importance of the stack emissions of CO_2 at a given time relative to their climate impacts at some point in the future when some of the emitted CO_2 may have been sequestered by regrowth of biogenic feedstocks. As such, the computation of the BAF for a feedstock in a region depends upon the climate impact of concern and the future point in time that is of interest, which is a choice that depends upon the specific regulation or policy that will rely on that BAF. If the objective of interest for the BAF computation is defined by short term processes, then the relevant time-period for the BAF computation needs to include relevant details on short term climate phenomena, which might be less important if the objective of interest is much longer term. In addition to identifying the relevant analytic time frame, knowing the objectives of interest would provide other information necessary to the assessment of the science underpinning the BAFs, such as the scale of demand for biogenic feedstocks, the anticipated time frame for that demand and eligible feedstocks to meet it, relevant spatial scope, and importance of including each type of GHG in the analysis.

While the SAB agreed with many of the recommendations developed by the Biogenic Carbon Emissions Panel in previous drafts of the report, it disagreed with the extended time frame recommended for BAF computation. There was much discussion between the SAB and the Biogenic Carbon Emissions Panel over the significance of the time horizon used to calculate BAFs. The Panel recommended that a general principle for determining the time horizon for BAF calculations should be to select a time horizon that fully accounts for the temporal dynamics for all feedstocks to accommodate the Agency's preference for a regulatory or policy ~~bias~~-neutral approach. During quality reviews the SAB disagreed with this recommendation noting that for regulatory initiatives that focus on objectives that reflect shorter time horizons, a general model with a long time horizon may not adequately capture the net carbon dioxide emissions relevant to the nearer-term outcomes. The SAB favors selecting the time horizon for calculating the BAF to comport with the objective under consideration, which is generally dependent on the regulation mandating use of that particular BAF. The Panel's previous reports remain available on the SAB [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252?OpenDocument"].

As we stated in our 2012 report and we reiterate here: this SAB review would have been enhanced if the Agency offered a specific regulatory application that, among other things, provided explicit proposed BAF objectives, which would in turn have defined the applicable boundaries regarding upstream and

downstream emissions in the feedstock life cycles. The 2014 Framework lacks specificity and is written in a way that is too generic, with too many possibilities that would require assessment of different underlying science. Rather than offering a lengthy menu of calculation options, the EPA Framework needs to define its scenarios and justify those choices. This would enable the SAB to evaluate the science underpinning those decisions and justifications.

Despite this significant limitation, the SAB offers overarching suggestions for moving forward with a framework for assessing the BAFs of biogenic feedstocks. In addition we offer specific responses to EPA's charge questions when possible and the SAB offers general guidance regarding the calculation of BAFs. EPA's equations were based on emissions (fluxes) with some adjustment terms to account for carbon mass escaping the system between the point of assessment and the point of emissions. In the enclosed report, the SAB recommends an alternative formulation based on changes in terrestrial (non-atmospheric) carbon stocks (or pools) such as the live stocks in biomass, dead stocks, soil stocks, etc., that explicitly incorporates the principle of conservation of mass. While the carbon-stock-based accounting system results in a formula for BAF similar to that of EPA's emissions-based approach, it offers multiple advantages: the component stocks are regularly inventoried and modeled by the scientific community; the different stocks can be aggregated and rearranged as needed or further subdivided; and it is appropriately constrained by conservation of mass and therefore the validity of the results can be assessed using mass balance calculations. Although this alternative formulation provides these benefits, other important modeling issues remain. These include selecting appropriate temporal or spatial boundaries, considering variability among classes of feedstocks, accounting for non-CO_2 greenhouse gases such as nitrous oxide and methane, and quantifying stocks and fluxes that are difficult to measure or estimate.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for CO_2 related to the use of biomass for electricity generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. We offer this caution about the model boundaries as defined by EPA's method and identified in the SAB review. In addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a whole different analysis and policy response.

Finally, EPA did not ask the SAB for feedback on its modeling approach. We think this was an oversight, given that modeling is critical to the development of the BAF and different modeling approaches can yield different results. The 2014 Framework employed an integrated model that captures economic and biophysical dynamics and interactions for some of its alternative BAF calculations; however, EPA did not offer explicit justification for its modeling choices derived from articulated criteria. In addition, the sensitivity of BAF responses to some underlying features of the model was not examined by the EPA or the SAB. Thus, we conclude EPA should identify and evaluate its criteria for choosing a model or models and examine the sensitivity of BAF estimates to key modeling features.

The SAB appreciates the opportunity to provide advice on the 2014 Framework and looks forward to your response.

Sincerely,

Enclosure

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board (SAB), a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The SAB is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names of commercial products constitute a recommendation for use. Reports of the SAB are posted on the EPA Web site at [HYPERLINK "http://www.epa.gov/sab"].

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Acronyms and Abbreviations

~~AVOIDEMIT~~	~~Avoided Emissions~~
BACT	Best Available Control Technology
BAF	Biogenic Assessment Factor
BAU	Business as Usual
CH_4	Methane
CO_2	Carbon Dioxide
~~CO_2e~~	~~Carbon Dioxide Equivalent~~
~~DOE~~	~~Department of Energy~~
EPA	Environmental Protection Agency
~~FASOM~~	~~Forestry and Agricultural Sector Optimization Model~~
GHG	Greenhouse Gas
~~GROW~~	~~Term in EPA's BAF equation representing net feedstock growth (or removals)~~
~~GWP~~	~~Global Warming Potential~~
PSD	Prevention of Significant Deterioration
N_2O	Nitrous Oxide
SAB	Science Advisory Board
USDA	U.S. Department of Agriculture

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1. EXECUTIVE SUMMARY

The EPA requested the SAB review a revised framework for accounting for biogenic carbon emissions, which the agency defines as "CO_2 emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, digestion, fermentation, decomposition, or processing of biologically based materials."[1] The goal of the 2014 Framework was to evaluate biogenic CO_2 emissions from stationary sources that use biomass feedstocks, given the ability of green plants to remove CO_2 from the atmosphere through photosynthesis. The 2014 Framework and its 2011 predecessor introduced the concept of a Biogenic Assessment Factor (BAF), which is the proposed adjustment for carbon emissions associated with the combustion of biomass feedstocks. The BAF is an accounting term developed in the Framework to denote the offset to stack emissions (mathematical adjustment) to reflect net carbon emissions after taking into account the sequestration of carbon in regrown biomass or soil, as well as emissions that might have occurred with an alternative fate had the biomass not been used for fuel.

Importance of Defining the Objective to Be Addressed by a BAF

The questions before the EPA in 2011 and presented for the SAB's review, were whether and how to consider greenhouse gas (GHG) emissions and decisions about best available control technology (BACT) for CO_2 emissions from biomass feedstocks used for electricity generation at stationary facilities. EPA proposed to address this issue by defining a term, Biogenic Assessment Factor, intended to be used to assess effects *relative* to the desired objectives. The 2014 Framework, however, removed the regulatory context, and did not include specific BAF calculations for any regulatory context, or the implementation details the SAB previously requested.

Because the EPA's 2014 Framework report does not identify the specific metric of climate impact (or "objective") with resulting regulations that a BAF estimate should reflect, BAFs that may be developed under the Framework could entail a wide range of objectives, e.g., temporal and spatial domains, total emissions, temperature, etc. While ideally it would be desirable to identify a universal methodology that could be applied to any of a wide range of potential objectives, doing so poses exceptional technical challenges and the concept was not endorsed by the SAB. Thus, the lack of specificity in the 2014 Framework document regarding the objectives that BAFs under it are expected to address made it very difficult for the SAB to assess whether the types of models, data, and baselines suggested by the Framework are appropriate, and has limited the ability of the SAB to fully address some of the charge questions. We thus preface the SAB's comments with this observation on the consequences of having made this revised 2014 Framework so unspecific with respect to its intended and potential applications. The SAB concluded that evaluation of EPA's plan for a science-based regulatory framework in the absence of defined regulatory objectives is not useful. Rather than assume a specific objective, or evaluate the charge questions across numerous putative objectives of interest, the SAB has focused on providing input on considerations that affect the usefulness and scientific integrity of EPA's approach in general.

[1] [HYPERLINK "https://19january2017snapshot.epa.gov/climatechange/carbon-dioxide-emissions-associated-bioenergy-and-other-biogenic-sources_.html"]

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Region- and Feedstock-Specific Biogenic Assessment Factors, baselines and modeling

As recommended previously by the SAB, BAFs should be feedstock-specific and region-specific and not facility-specific. Facility-specific BAFs are conceptually and practically challenging to estimate due to the absence of well-defined spatial boundaries for feedstock supply to each facility and the role of market-induced effects on land use, on biomass production and market demand for fiber, and on carbon stocks across space. To obtain a region-specific BAF for feedstocks, it is necessary to address region-specific, feedstock-specific demand for biomass and to assess the impact of this increased demand for biomass on net carbon stocks. Changes in demand for biomass feedstocks should be assessed based on historical data on forest carbon stocks, resource use, and observed information on current and planned expansions to facilities using biomass feedstocks. *There is no single answer to what these BAFs should be, as not all biogenic emissions are carbon neutral nor net additional to the atmosphere, and assuming so is inconsistent with the underlying science.*

Projections of the interactions that must be assessed to compute a BAF can be obtained from diverse model types, from simple empirically and statistically-based models, to complex integrated assessment models that combine biophysical and economic factors. For all model types, sensitivity and uncertainty analyses are needed to adequately interpret the results and understand the dependency of the BAF on the choices and assumptions used as part of its computation.

To compare changes in any system over time there must be a reference scenario (without increased demand for biomass feedstocks) against which to assess the net impacts on the variable of interest. In 2012, the SAB recommended a future anticipated baseline approach to capture the *additional* CO_2 emissions to, or uptake from, the atmosphere created by any increased use of biomass feedstocks for electricity generation. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis *along with* a reference point approach in its 2014 Framework. Both the future anticipated baseline and the reference point baseline (with regular updates) are challenging to apply due to data and modeling limitations.

Regardless of the baseline structure chosen (adjusted reference or future anticipated), validation and evaluation of the model used to compute the BAFs will be critical. Model validation is essential to assessing any model's ability to replicate observed phenomenon over time, ensuring that simulations based on the model appear reasonable. Similarly, understanding model sensitivity to input parameters and assumptions is important with respect to assessing model applicability over time. The model selected for estimating BAFs should be reviewed and updated at regular intervals, capturing observed changes in economic and land use conditions that may be due to increased biomass demand or other related conditions, as well as the latest scientific information on biophysical and biogeochemical properties of feedstocks. The appropriate review interval should be selected based on the timeframe of the regulatory objective(s) as well as the timeframe associated with updates to the underlying data.

Charge Question 1

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Temporal and Spatial Scales

A sustained increased demand for biomass feedstocks by stationary facilities in a region is likely to trigger changes in carbon stocks through one or more pathways that could generate a new (steady-state) equilibrium stock of carbon that may be higher or lower than the current stock of carbon on the land. The demand for biomass feedstocks for use in stationary facilities can affect carbon stocks by increasing harvesting intensity for standing biomass, diverting biomass feedstocks from other non-energy products and landfills, converting land from other uses to plant new biomass feedstocks for the future, and utilizing biomass residues that might otherwise decay. Each of these responses may differ over time, and thus, the overall effect of all these responses together on demand for biomass feedstocks may differ over time. Therefore, the time period selected for estimating the carbon stock or net carbon emissions impacts of an increased demand for biomass feedstocks can strongly affect that estimate. The selection of the time period for assessment is not a purely scientific question, and may be driven primarily by the objectives associated with the use of of BAFs to be estimated using this Framework. For example, consider an objective to limit peak planetary warming versus an objective of controlling emissions of greenhouse gases in 2050: the same feedstock in the same region could have widely varying impacts on terrestrial carbon stocks because the timeframe defining the endpoint of the relevant analysis would differ. Since BAFs will computed to serve specific regulatory objectives, there are no scientific criteria by which to pick a single 'right' timeframe for their determination independent of their regulatory context (Ocko et al 2017).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for this application. A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks.

Stock-Based Accounting Preferred to Emissions-Based Accounting

Carbon accounting associated with determining BAFs should be based on changes in carbon stocks on the land rather than changes in carbon emissions (as used in EPA's 2011 and 2014 Frameworks). A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated, subject to validation via mass balance and an existing comprehensive system of empirical measurements is already in place for the US. The stock-based approach comports with the current conventions in carbon accounting, which essentially use input-output tracking of carbon throughout a system with well-defined boundaries. These stocks can be aggregated and rearranged as needed, and they are appropriately constrained by conservation of mass and therefore can checked and precision can be determined using mass balance calculations, in addition to other checks.

policy

Two Cumulative Biogenic Assessment Factor Approaches

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The SAB recommends a cumulative carbon accounting metric; however, there are alternative ways to calculate cumulative BAFs. EPA's cumulative BAF (called BAF_T in the 2014 Framework) applied to stocks is one option, reflecting the carbon stocks at the end of the time horizon—specifically, changes in carbon stocks by time, T. One can also calculate a cumulative BAF that is based on the accumulation of annual differences in carbon *stocks* on the land *over the time horizon until equilibrium is reached*, here called $BAF_{\Sigma T}$. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach, i.e., the difference in carbon stocks *at the end of the selected time horizon.*

Charge Question 2

Scales of Biomass Use and Modeling Approach

Projections for aggregate demand for all biomass changes should be bounded by historical data on resource use, observed information on current and planned expansions to facilities using biogenic feedstocks, and reasonable projections of cost-effective deployment of biomass feedstocks for meeting the energy/feedstock needs of stationary facilities.

In addition, regular retrospective evaluations of observed levels of demand and the mix of feedstocks would enable revisions to EPA's estimates of feedstock demand. Retrospective evaluations of BAF performance will be important for understanding how effective the modeling has been in predicting what occurred. Thus, projections about biomass feedstock demand should be revised based on actual observations, and these updated demands should be used to inform modeling that generates BAFs.

Recommendations

As we have observed above, a sound biogenic carbon accounting approach for estimating BAFs will depend on the specific regulatory objectives for those BAFs, which are yet to be defined. Recognizing this limiting factor in the SAB's ability to review the 2014 Framework, we make the following recommendations.

1. EPA should identify and evaluate its criteria for choosing a model and modeling features that affect BAF results. EPA should explore the sensitivity of BAFs to different modeling approaches, assumptions, transaction costs, and uncertainties in model input parameters.

2. Stationary facilities require a continuous supply of biomass feedstocks, thus a landscape approach is appropriate and likely most reliable for accounting for the impacts of feedstock demand on carbon stocks.

3. The estimate of the direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no optimal time horizon for evaluating these impacts, and it may be primarily determined by the regulatory context mandating use of BAFs.

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4. Changes in carbon stocks (e.g., live and dead biomass, soil, products, material lost in transport and waste), should be used to account for biogenic carbon, rather than an emissions (flux-based) approach.

5. The SAB suggests exploration of two cumulative BAF metrics. Until the implications of the different metrics are clear, the SAB recommends using the metric proposed by EPA, i.e., net changes in stock over a specified time.

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2. INTRODUCTION

2.1. Background

EPA's Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (U.S. EPA 2014).

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for CO_2 emissions associated with the use of biogenic feedstocks in stationary facilities, taking into account the biological carbon cycle associated with the growth, harvest, and processing of plant biomass. This mathematical adjustment to stack emissions is needed because of the unique ability of biological systems to sequester CO_2 from the atmosphere through photosynthesis in living biomass, to sequester carbon in dead biomass and soil, and to release CO_2 through respiration and biologically-mediated decay of organic matter. These attributes of ecosystems mean that there can be wide variation in the net effect of using biomass feedstocks in stationary facilities on emissions of carbon dioxide to the atmosphere and thus it is scientifically indefensible to assume all bioenergy has no net carbon dioxide emissions to the atmosphere, or the reverse, that all emissions represent a net addition to the atmosphere. The BAF is an accounting term developed in the Framework to estimate the net CO_2 emissions to the atmosphere over a specified period of time associated with burning biomass feedstocks to produce energy. These net emissions reflect the changes in carbon stocks of above and below ground biomass (live and dead), soils, and wastes. The 2014 Framework is a revision of the 2011 Framework (U.S. EPA 2011), which the SAB previously reviewed (U.S. EPA SAB 2012).

The EPA's charge to the SAB (Appendix A) requests advice and recommendations on its revised 2014 Framework, which was developed with consideration of the SAB's 2012 recommendations as well as the latest information and input from the scientific community and other stakeholders. The EPA asked the SAB to review and offer recommendations on specific technical elements of the 2014 Framework for assessing the extent to which the production, processing, and use of biogenic feedstocks at stationary facilities results in net emissions of CO_2 to the atmosphere so that it could be quantified through calculation of a BAF.

To conduct the present review, the SAB Staff Office reconstituted the Biogenic Carbon Emissions Panel (Appendix B), which had reviewed the 2011 Framework. That panel met multiple times between March 2015 and August 2017. The Panel presented a draft report (February 2016) to the SAB for quality review. The SAB quality review was conducted in March 2016; this quality review resulted in requested revisions from the Panel. The revised draft report (June 2017) was reviewed by the Board in 2017. The 2017 revision of the report was not approved by the SAB based on the deliberations of the quality review. The present report is a product of SAB's direct efforts and utilizes portions of the Panel's report. Previous drafts of the Panel's report are retained on the SAB website and available [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235dac747c16fe985257da90053f252!OpenDocument&TableRow=2.2" \l "2."].

The 2014 Framework does not provide the regulatory context, specific BAF calculations for that context, or the implementation details the SAB requested in its review of the 2011 Framework. That is, EPA's Framework report does not identify the specific metric of climate impact (or "objective") that a

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BAF estimate should reflect, and further notes that BAFs that may be developed under the Framework could entail a wide range of objectives, depending on the regulation or policy-specific approach that would require use of a BAF. (For example, some regulations may impose objectives related to different time horizons than others; similarly, under some regulations the BAF may need to address a temperature impact objective, while other regulations may impose a net CO_2 emissions objective.) Lack of specificity in the Framework document regarding the objectives to be estimated makes it very difficult for the SAB to assess whether the suggested types of models, data, and baselines are appropriate. While it would, in this situation, be desirable to identify a universal modeling methodology that could be applied to any of a wide range of potential objectives, this poses significant new analytical and data challenges on the Framework, and the SAB is not endorsing such an approach. Thus, we note as a preface to this set of SAB comments that a consequence of having made the 2014 Framework so general in its potential applications is that it has limited SAB's ability to fully address the charge questions presented to it for this review.

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3. OVERARCHING COMMENTS

This section addresses issues that lie outside the scope of EPA's charge questions, but which the SAB considered critical to place the responses to the charge questions in context. The charge questions are narrowly focused on specific technical aspects in the structure of the 2014 Framework. However, the SAB had important general advice regarding the Framework. This first section outlines that advice.

3.1. Defining Objectives through the Regulatory Context

For its review of the 2011 Framework, the SAB requested and was given a regulatory context for use of BAFs that would result from the biogenic CO_2 accounting framework. The SAB was told that the 2011 Framework was intended to guide the determination of CO_2 emissions from regulated stationary sources under the Clean Air Act, specifically those facilities receiving a prevention of significant deterioration (PSD) air permit and that were required to conduct a best available control technology (BACT) analysis for CO_2 emissions. The question before the agency, and hence the SAB, was whether and how to consider biogenic greenhouse gas (GHG) emissions in reaching thresholds for permitting and decisions about BACT for CO_2 emissions from the use of bioenergy in stationary facilities.

The agency has removed this regulatory context from its 2014 Framework, and the EPA's charge questions seek guidance on issues related to the choice of temporal, spatial and production scale for determining BAFs in a regulatory-neutral context. In the absence of a specific regulatory context, which would define the objectives that a BAF must estimate, the SAB limited its review to providing general comments about how to consider the questions posed. More specific answers to the questions posed will vary with the objective (as defined by the regulatory context), most notably the appropriate time period over which to determine the net biogenic emissions, and to a lesser degree, the appropriate geographical scale for consideration.

A regulatory context with explicit objectives would clarify if the procedures for determining the BAF will need to account for the emissions of all greenhouse gases that alter the climate. If this is the case, then it will be important that the analytic methods described by the Framework account for the effect of biogenic feedstocks on non-CO_2 gases such as N_2O and CH_4 and to examine how the emission or uptake of these gases differ across space, time, and feedstocks. Given the large difference in the mean residence time of these gases in the atmosphere, their relative importance can vary widely over different time horizons. If climate impact over 20 or 40 years is the objective, then methane and carbon particulate emissions could be very important, while if the objective's period of concern is hundreds of years, their importance will drop significantly (Shoemaker, et. al., 2013). Non-CO_2 gases are particularly important for feedstocks grown with nitrogen fertilizer and for waste materials from landfills.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for carbon dioxide related to the use of biomass in stationary facilities for energy generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. If, for example, biomass pellets were sourced from old growth forests, this would pose unique risks that would not be reflected in a BAF calculated for net effects on carbon dioxide. We offer this caution about the model boundaries as defined by EPA's method and identified in the SAB review. In

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addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a different analysis and regulatory response.

Recommendation

- BAFs will vary depending on their specific objective, which will depend upon the regulatory context, particularly in selection of the time horizon and geographic scope. Thus, future efforts to define specific biogenic accounting factors should be conducted in a regulatory-specific context, with the objectives and relevant time frame specified.
- It is inappropriate to use default assumptions, including assuming there are no net emissions or that all emissions are additive.

3.2. Baseline Approach

To compare change in any system over time, there must be a baseline scenario against which to assess changes, in this case, changes due to demand for biogenic feedstocks; a baseline allows different scenarios to be compared. In the 2011 Framework, the EPA assesses the estimated net change in land-based biogenic CO_2 fluxes and/or carbon stocks between two points in time, with the first time point called the reference point. In the 2012 SAB report, we noted temporal problems with the reference point baseline approach. The EPA has acknowledged this in its 2014 Framework and included a future anticipated baseline analysis alternative along with a reference point baseline approach. The 2014 framework notes that the choice of baseline (reference point or anticipated) depends on the question to be answered and the specific context in which the framework is applied.

The SAB's 2012 advice on the anticipated baseline approach explored the use of complex modeling in order to try to capture interactions among the market, land use, investment decisions, and emissions and ecosystem feedbacks, and to construct a counter-factual scenario that does not include increased bioenergy use. In the case of long rotation feedstocks, biomass feedstock demand can affect carbon stocks in many ways including the age of trees harvested, the diversion of forest biomass from traditional forest product markets to bioenergy, and the rates of afforestation and deforestation. Estimating the net effect of these changes on carbon stocks requires a model that integrates market demand and supply conditions with biophysical conditions that determine growth of forest biomass, losses via decomposition, carbon sequestration and fluxes due to harvests and land use change and incorporates the spatial variability in these effects across the U.S. The complexity of such a modeling approach can make it difficult to parameterize and validate, and thus poses a significant challenge for use in any context. Extra effort will be needed to provide the public with thorough sensitivity analyses of parameters and model assumptions, and explicit recognition of model uncertainties in resulting BAF estimates.

Also, consistent with the SAB's 2012 recommendations, the EPA has now moved toward a "representative factor" approach that would include an assessment of the biogenic landscape attributes (type of feedstock, region where produced). The EPA initially considered calculating a BAF for an individual stationary facility; however, the data needs for a facility-specific approach are daunting if they are to be accurate (e.g., case-specific measurements and calculations of carbon stocks and chain-of-custody carbon accounting, integration of land use changes on a broader landscape level). EPA's use of

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a representative factor approach is an advance in its accounting methodology, although overly-broad feedstock categories may not reflect important extant or likely future variation in feedstock production or processing (e.g., roundwood in the Southeast, logging residues in the Pacific Northwest, and corn stover in the Corn Belt). The overall approach is a positive development, but caution is required to ensure such inclusiveness does not produce unintentionally negative outcomes, e.g. feedstocks with large net emissions to the atmosphere lumped together with those with more limited net emissions. The EPA should evaluate the "representativeness" of the factors and refine the approach over time with additional data.

As stated in the SAB's 2012 report, there are tradeoffs between ease of implementation (transaction costs), generalizability (getting it right at every location), accuracy (getting the overall stock change correct), and regulatory effectiveness (ensuring that the regulatory objectives are being met). The SAB continues to recognize the difficulty of undertaking the recommended anticipated future baseline approach, and practicality should be an important consideration in the agency's decision making. While the reference point baseline approach has significant limitations as noted in the SAB's 2012 report, these might be mitigated if regular updating with empirical data to capture regional carbon stock changes (increases or decreases) were employed. All methods considered should be subject to an evaluation of the costs of implementation and compliance and weighed against any increase in accuracy that they might yield. Ultimately it is critical that there is a balance among these considerations.

Recommendation

- The EPA should identify and evaluate its criteria for choosing a model and its underlying assumptions with regards to how these criteria and assumptions affect the robustness and reliability of calculated representative BAFs. In addition, the EPA should periodically update and validate the selected model to incorporate the latest scientific knowledge while ensuring that the model outputs are consistent with empirical observations (e.g. shifts in measured carbon stocks as determined the Forest Inventory Analysis program). Any model chosen should be subject to sensitivity analysis to evaluate its efficacy under different conditions and to identify data needs and prioritize future research.

3.3. Alternative Fate Approach for Waste-Derived Feedstocks

In 2012, the SAB recommended that the EPA consider alternative fates (i.e., if not used as fuel for electricity generation or process heat) of waste-derived feedstocks diverted from the waste stream, e.g., whether these feedstocks might decompose over a long period of time, whether they would be deposited in anaerobic landfills, whether they would be diverted from recycling and reuse, etc. In the 2014 Framework, the EPA has conducted extensive alternative fate calculations; however, the agency drew a narrow boundary around point source emissions and neglected other significant considerations that affect the GHG footprint of alternative municipal solid waste management scenarios. Specifically, the EPA neglected to quantify a potential alternative fate of municipal solid waste through landfill-derived methane combustion. Under the Clean Air Act New Source Performance Standards, the EPA requires landfills above a certain size to, at a minimum, collect and control landfill gas (e.g., through flaring or use). As such, a baseline of direct venting is misleading, although almost all these facilities are likely to produce large emissions of methane, even when in compliance with current regulations (Lamb et al 2016: [HYPERLINK

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"file:///C:\\Users\\tcarpent\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\9EYAZ1S8\\www.epa.gov\\lmop\\basic-information-about-landfill-gas"]). The relative rankings of BAFs across waste treatment options assessed in the 2014 Framework might change considerably if a more complete accounting were undertaken (e.g., energy recovery from landfill-derived methane and combustion of waste, and carbon storage associated with landfills.)

3.4. Temporal and Spatial considerations in Biogenic Assessment Factor Calculations

The goal of the EPA Framework reviewed is to account for effects of biomass feedstocks used for energy generation at stationary facilities on terrestrial carbon stocks. BAFs are a carbon accounting method based on expected future changes in carbon stocks (measured in tons of carbon). They are designed to assess the net contribution of CO_2 from a stationary facility that uses biomass feedstocks, due to shifts of terrestrial carbon to and from the atmosphere over a specified period of time. The time scale selected will vary depending on regulatory-defined objectives (e.g., reduction of GHG emissions in 2050 or 2100, or limiting global temperature change resulting from greenhouse gas emissions). Over the selected time period, all greenhouse gas impacts (not just CO_2) – both positive and negative – should be accounted for (as completely as is feasible).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for the application EPA defines (stationary facility for energy production). A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks. As noted by Cintas et al. (2016), "assessment at the landscape scale integrates the effects of all changes in the forest management and harvesting regime that take place in response to – experienced or anticipated – bioenergy demand. Taken together, these changes may have a positive, negative or neutral influence on the development of forest carbon balances." Landscape level accounting of effects of forest-based feedstocks on carbon stocks can result in a net gain or loss of carbon stocks in the near to medium term; a carbon debt could be followed by a carbon dividend or the other way around.

BAFs are a carbon accounting tool for assessing CO_2 emissions from facilities that consume biomass feedstocks for production of energy and are not life cycle assessments of net greenhouse gas emissions or their climate change effects. The distinction is that not all indirect systemic effects are considered in the BAF, nor are all GHG effects included. We also underscore our caution that the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, regulatory efforts, market forces, or natural causes. If such monitoring demonstrates changes that are not included in the model used to develop the BAF, the BAF should be updated to align with the empirical data.

Recommendation

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- Stationary facilities require a continuous supply of feedstock, thus a landscape approach is appropriate and likely most reliable for accounting for the impacts of feedstock demand on carbon stocks.

RESPONSES TO EPA'S CHARGE QUESTIONS

3.5. Temporal/Spatial Scale for Biogenic Accounting

Charge Question 1: What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

There are several key factors that impact the dynamic nature of the BAF for a specific feedstock and region. The first is that the increased demand for biomass feedstocks in a region could potentially be met by a variety of sources obtained from the agricultural and forestry sectors, including annual and perennial agricultural crops, short rotation woody biomass and pulpwood, and crop and forest residues. Any increase in demand might involve using a larger proportion of an existing resource or diversion from non-energy products and landfills, converting land from other uses to growing biomass feedstocks, changing use of existing feedstocks, utilization of residues that would otherwise decay over some period of time. The effect of increased demand for biomass feedstocks on carbon stocks will depend on the mix of these feedstocks demanded and the scale of demand for these feedstocks.

Second, different biomass sources have different effects on carbon stocks over different timeframes. The plant systems, e.g. forests, agronomic systems, producing feedstocks differ in their rate of growth/regrowth, yield, potential to sequester carbon in biomass and soils, decay rates after harvest, and the type of land-use change that accompanies their production. These effects continue after the feedstock has been consumed by a stationary facility. We therefore recommend computing a cumulative BAF over the relevant time horizon. This cumulative BAF would be based on the difference in carbon stocks between a scenario without change (either computed using a reference point or anticipated baseline) and the increased biomass feedstock demand scenario and would vary with the time horizon selected by the objective in the relevant regulations.

Key principles for calculating changes in the net carbon stocks should include: (1) the positive and negative impacts of demand for biomass over time, (2) a system-wide (landscape and economy) approach to account for direct and indirect effects, and (3) consistency across each region. Selecting different time horizons for different feedstocks being used to meet the same regulatory objective would be inappropriate as it would yield inconsistent effects.

Determining the scale of appropriate regions for calculating BAFs will require balancing similarity in the biophysical characteristics, similar growing conditions (growing season length, vegetation type) and economic factors, biomass demand, with ensuring that the edge to volume ratios of the regions are small enough to ensure minimizing incentives to manipulate the movement of biomass feedstocks among regions due to differing BAFs.

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To fully account for all positive and negative terrestrial effects over time, we recommend using the "emissions horizon" that is determined to be relevant by the specific regulatory objective. As defined by the EPA, this "emissions horizon is the period of time during which the carbon fluxes resulting from actions taking place today actually occur …" (U.S. EPA 2014). If the objective associated with for a given BAF is to have an effect on greenhouse gas emissions by a certain date, then the impacts aggregated by that date are the relevant metric to assess meeting the objective, and that date is the appropriate time horizon under which the BAF is calculated. Accordingly, there is no single time horizon that will effectively address all policies or feedstocks since feedstock net effects are time-dependent and desired objectives for regulatory changes target different time horizons. The SAB does not support a single time horizon as appropriate for estimating BAFs, because the computed values can vary significantly over differing time horizons and different objectives will be met over different time horizons.

The Panel suggested that the time horizon should be the length of time it would take for the effect of increased demand for biogenic feedstock on the carbon cycle to reach a steady-state. This occurs when the difference in carbon stocks between the increased biomass feedstock demand scenario and the business-as-usual scenario is no longer changing or when the difference is approaching an asymptote. This could result in a very long time horizon being selected for the BAF calculation, potentially hundreds of years if all feedstocks across all regions were to be included. The selection of such a time horizon would mean that for regulatory objectives with shorter time horizons (e.g., meeting a 2050 emissions target), the accounting would not align with relevant effects of biomass feedstock use at stationary sources on the regulatory objective. Whether it would be appropriate to use a model that can estimate effects over a much longer time horizon to estimate a BAF requiring a a shorter time horizon will depend on whether that model produce reasonable estimate of impacts at the nearer term point in time as well.

Several factors determine the difference in carbon stocks between the business-as-usual scenario and the increased biomass feedstock demand scenario. A major factor is the "speed" with which carbon stocks respond after harvest; this can be influenced by several factors: the speed with which a feedstock regrows and can be harvested again, the mix of feedstocks produced, and the rate at which soil carbon stocks change. Thus, the mix of feedstocks used can influence the shape of the curve and when it reaches equilibrium.

Previous studies have shown that estimates of the effects of biomass harvest on carbon stocks depend on the spatial scale of consideration (stand level or landscape level), the initial conditions of carbon stock on the land (e.g., managed forestland, old growth forestland, or agricultural land), the management practices used, and the time horizon over which effects are measured (Walker et al., 2010; Jonker et al., 2014; Mitchell et al., 2012; Galik and Abt, 2012; Ter-Mikaelian et al., 2015). Harvest of an existing forest stand for use as a feedstock results in an immediate reduction of carbon on the site; the amount of carbon lost at the stand level is directly related to the intensity of the disturbance. At a stand level, harvest followed by regrowth (most US forests regenerate without intervention/planting) usually results in a cycle of loss followed by gain. The amount of carbon regained on the site can vary: in some cases, all is regained, in others only part is regained, and in others, more can be gained than is released.

Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed asynchronously; the order in which losses and gains occur becomes meaningless at the landscape level

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because both simultaneously occur. Thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs for biomass feedstocks used at stationary sources. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the business-as-usual scenario, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.

Biomass, particularly from forest sources, is also used for producing non-energy products. The demand for biomass feedstocks for energy generation can lead to a diversion of biomass from those products and lead to an immediate reduction in carbon stocks in products. It is also possible that anticipation of future demand for biomass feedstocks by stationary facilities could lead to land conversion, reforestation and retention, or accumulation of carbon stocks in a growing forest. In general terms, the amount of either net loss or net gain of carbon on the landscape is influenced by changes in many factors including those influencing net primary production and removals, and the net effect can be expected to vary over time.

When agricultural feedstocks are harvested annually from land under continuous production, the time lag between harvest, CO_2 emissions from conversion to energy, and regrowth on land is likely to be close to one year, and the harvested carbon will be fully regained, with no net impact on above-ground carbon stocks. The production of these feedstocks may directly affect carbon stocks below-ground by increasing or decreasing soil carbon stocks relative to the use of the land in the business-as-usual scenario. The demand for biomass feedstocks can also affect carbon stocks by leading to a change in the use of land which could either release carbon stored in the land (for example if permanent grasslands are converted to annual agricultural production) or accumulate carbon on the land (for example through reforestation as annual cropland is converted back to forests).

Recommendation

- The estimate of direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no optimal time horizon for evaluating these impacts, and it may be primarily determined by the regulatory context mandating use of BAF.

Charge Question 1(a): Should the temporal scale for computing biogenic assessment factors vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.

Charge Question 1(a)(i). If temporal scales for computing biogenic assessment factors vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?

Charge Question 1(a)(ii). Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?

Charge Question 1(a)(iii). Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default biogenic assessment factors versus crafting policy specific biogenic assessment factors?

Charge Question 1(b). Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?

The responses to questions 1(a), 1(a)(i), 1(a)(ii), 1(a)(iii), and 1(b) are combined because these questions all relate to goals or criteria that may affect choices of differing temporal scales for calculating BAFs.

Question 1a asks specifically if the temporal scale for computing BAFs should vary by regulatory policy. As noted in the overall response to Charge Question 1 (above), the SAB concludes that the BAF computation should be informed by the regulatory objectives, including with respect to time.

If there are different objectives in multiple regulations mandating use of BAFs (as discussed in charge question 1(a)(i)), there are no overriding scientific principles that can be applied *a priori* to guide alignment in the tools to be used for calculating BAFs for different objectives.

One could advocate for a host of approaches to selecting a time horizon for evaluation; all would be plausible but not inherently aligned with the objective of the regulations being promulgated. At the extremes one could consider only the carbon accounting over the year in which the biomass was combusted; such an approach would mean that almost all feedstocks would be assigned a BAF close to one, representing no net benefit to reducing atmospheric carbon dioxide concentrations. Conversely one could only consider net impacts on the carbon cycle over several hundred years, which would mean for most feedstocks the BAF would be close to zero (assuming steady demand and unchanged rotation lengths thus allowing stocks to come into equilibrium), indicating all biogenic emissions being net beneficial to the atmosphere. Neither of these approaches would align with the most likely objectives of BAFs; however, neither is inherently correct or incorrect.

The time horizon for consideration of carbon stock changes should be chosen based on the specific objective of a regulation, once it is identified (e.g., minimizing net greenhouse gas emissions over a specified period or temperature increase by a certain date). The SAB makes no assertion regarding the appropriate regulatory use of the BAF and thus supports no specific time horizon selected independent of a regulatory requirement.

Charge Question 1(c). Should calculation of the biogenic assessment factor include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in

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which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?

Accumulating all effects of the use of a biogenic feedstock over a time horizon is preferred to a marginal or instantaneous ("per period") BAF. (For the purposes of answering this question, the SAB interprets "marginal" to mean "annual" or "per period" so as to distinguish it from the meaning of "marginal" that typically refers to the last unit of emissions or the additional effect of the last unit of biomass.)

As described in the overall response to Charge Question 1 (above), the SAB recommends a cumulative carbon accounting metric; however, there are alternative ways to calculate cumulative BAFs. EPA's cumulative BAF (called BAF_T in the 2014 Framework) applied to stocks is one option, reflecting the carbon stocks at the end of the time horizon—specifically, changes in carbon stocks by time, T. One can also calculate a cumulative BAF that is based on the accumulation of annual differences in carbon *stocks* on the land *over the time horizon until equilibrium is reached*, here called $BAF_{\sum T}$. By accumulating annual differences across the projection period, this alternative cumulative BAF metric attempts to incorporate "residence time" in the sense that it is a proxy for the length of time carbon stays in the atmosphere until it is modified by changing stocks of carbon on the land. While intended to generate a single BAF term at the end of the selected time horizon, either computation can be evaluated at any time of interest. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach, i.e., the difference in carbon stocks *at the end of the selected time horizon*.

The choice of an appropriate cumulative BAF should be informed by a scientific assessment of the dynamics of additions to atmospheric carbon stocks as well as the complexities and uncertainties of these determinations, ensuring the accounting is accurate and verifiable. Both cumulative BAFs attempt to capture net changes in biogenic carbon stocks. A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated and are still subject to mass balance.

With either approach to evaluating BAFs, caution is advised with projections into the future. A BAF is inherently based on some type of modeling that employs assumptions about the relationship of variables in the future based on current observations. These assumptions may not be robust in the future. Each BAF will need to be assessed periodically to see if changing conditions warrant a revision (Bucholz et al. 2014).

Carbon accounting for biogenic emissions can be framed either using differences in carbon emissions to the atmosphere or using differences in carbon stocks on the land. Conservation of mass dictates that any carbon taken from the land (through increased harvests or other disturbances) will result, in the near-term, in equivalent increases of carbon in the atmosphere, followed by longer-run changes in ocean and land-based carbon. Thus, these approaches are compatible, but examining changes in stocks is operationally more direct and can be done periodically, rather than requiring continuous measurements to be accurate. However, both approaches should account for changes within the boundaries of the analysis, such as import and export of biogenic feedstocks and other associated products.

Long-Term Trends in Biogenic Assessment Factors

The Panel has suggested that cumulative BAFs might approach zero as T is reached. However, that is only true for $BAF_{\Delta t}$ and not the cumulative BAFs – BAF_T and $BAF_{\sum T}$. Mathematically cumulative BAFs

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are hyperbolic functions once T is reached and have extremely long "tails", representing a period of net CO_2 emissions to the atmosphere.

An approach to determining a baseline that includes an historical time period could be used to periodically reset a reference baseline based on re-measuring carbon stocks on the landscape using data from existing inventory programs. Carbon stock measurements have been made for more than a half century in the US, offering a robust record of change. This approach could improve the accuracy of the baseline over time; however, as noted above, the preference for use of a reference or future anticipated baseline depends on the objective. Future changes in growth-to-harvest ratios could be used to inform the model assumptions and modify the BAF that would be applicable going forward. This could create long-term incentives for sustainable management of land resources. In any accounting framework that assumes future regeneration and regrowth, it is important to periodically test this assumption against actual data as they become available. If assumptions of future regeneration and regrowth are not supported by observations, adjustments need to be made to models that are used to determine BAFs.

Recommendations

- The SAB recommends formulating BAFs based on changes in carbon stocks (terrestrial pools such as live, dead, soil, products, material lost in transport and waste), rather than an emissions-based (flux-based) approach, because the former comports with conventional carbon accounting, has well-defined boundaries, and follows the conservation of mass.

- The SAB suggests consideration of two cumulative BAFs—that proposed by EPA and an alternative metric that takes into account the changes in terrestrial carbon stocks over time. The appropriate cumulative metric for calculating BAFs will depend on the understanding of the carbon system and climate response for which there is uncertainty.

Charge Question 1(d). What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions ex post), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is appropriate to periodically revise the modeling and the BAFs. The goal of such revisions would be to update underlying economic and biophysical assumptions and modeling trends in light of new data to reduce uncertainty and to increase accuracy of future projections.

A retrospective comparison would compare model-projected behavior to newly available historical observations and estimates, such as regional feedstock demand, land-use changes (e.g., reforestation, management intensity, forest rotations characteristics and conversion of land to other land uses including dedicated energy crops), and forest carbon measurements and estimates (both level and composition). It would be important to re-examine parameters, functional forms, and other assumptions of the modeling approach as part of an *ex post* evaluation.

3.6. Scales of Biomass Use

Charge Question 2: What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary

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sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?

Charge Question 2(a). Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
Charge Question 2(b). What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?

The responses to questions 2(a) and 2(b) are combined below because both questions relate to the size of the simulated change in demand for biomass feedstocks. The complexities are large and any predictions on scale of demand shock can only be done effectively in a regulatory context as they are very challenging to define otherwise.

If the EPA's goal is to obtain a region-specific BAF for a feedstock, it will be necessary to project region-specific and feedstock-specific demand for biomass. Since the BAF for a feedstock could differ depending on the method of production (for example, the soil carbon implications of corn stover will depend on the type of tillage practice used and the amount of residue harvested), it will be appropriate to have the BAF for a feedstock in a region reflect the methods used to produce that feedstock. To the extent that BAFs depend on technology and emissions control regulations at a stationary facility in a region, they could also be defined in terms of specific technologies.

Charge Question 2(c). Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?

In the absence of a specific regulation to model, the SAB cannot offer general recommendations for a representative scale of demand shock.

Charge Question 2(d). Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?

Charge Question 2(e). For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).

The responses to questions 2(d) and 2(e) are combined because both questions relate to modeling biomass feedstocks in isolation or jointly.

In the absence of a mandate for use of specific feedstocks or incentives for specific types of bioenergy which might be prescribed in a regulatory framework, and which would inform the feedstock-specific demand that should be modeled, a reasonable approach is to model the aggregate demand for feedstocks.

This approach assumes facilities are constantly seeking their least-cost alternative. An aggregate demand could be imposed on the model and used to determine demand for different feedstocks in different regions. This would allocate demand across feedstocks as well as within each category to simulate a given target aggregate demand determined by the market's ability to draw from the least cost combination of feedstocks.

Charge Question 2(f). How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?

Default BAFs would likely vary by the scale of demand. In fact, a single set of default BAFs is unlikely to be robust across a wide range of scales of demand. The scale of demand is likely to influence the mix of feedstocks that is viable to produce because it can be expected to affect the market price of biomass. Low levels of demand for biomass may be met relatively easily by crop residues, forest residues and mill residues; high levels of demand could lead to dramatically increased harvests of forest biomass or production of dedicated energy crops. The BAF of a feedstock in a region can be expected to vary depending on whether there is a 1-million-ton increase in biomass demand or a 1-billion-ton increase in biomass demand.

In the absence of information about the scale of demand, BAFs could be determined for different threshold levels of aggregate demand for biomass feedstocks and consequent feedstock/region-specific demand.

Charge Question 2(g). Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?

While the methodological framework for different policies could be similar, we expect differences as follows: (1) BAFs that are tied to a particular regulatory approach, versus a particular period of time, would be based on simulating the aggregate and feedstock-specific demand that is expected to emanate from that regulation, while regulatory neutral factors would be based on various exogenously specified quantities of demand for biomass and corresponding endogenously determined levels of feedstock specific demand, and (2) different regulations may require different production and use practices, and thus result in different biogenic factors. Isolating the extent to which expected increase in demand for biomass and its consequences for CO_2 emissions can be attributed to a specific regulation (when there are multiple regulations inducing a shift to renewable energy) is likely to be complicated and challenging to convert into regulatory-specific BAFs. It could also create unintentionally negative incentives for feedstock choice to comply with various regulations.

Charge Question 2(h). What considerations could be useful when evaluating the performance of the demand shock choice ex post, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is likely that the observed feedstock demand in response to a specific regulation will differ from the forecast because the regulation can be expected to increase demand for feedstocks with lower BAF and decrease demand for feedstocks with a high BAF. Since feedstock-specific demand and the feedstock

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BAFs are likely to be jointly determined, while the approach proposed above determines them sequentially, divergence between model simulated demand for feedstocks and observations is inevitable.

An evaluation using actual data would also allow revisions to the EPA's estimates of feedstock demand changes (as discussed in response to Question 1d) based on updated data. To improve the performance of the model for assessing BAFs retrospectively, quantities of biomass feedstock (by feedstock category) harvested could be updated with actual observations. New data should improve the estimate of the portion of total biomass demand that is attributable to stationary facilities. This information could be used to improve BAFs.

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REFERENCES

Bucholz, T., Prisley, S., Marland, G., Canham, C. and Sampson, N. (2014) Uncertainty in predicting GHG emissions from bioenergy. *Nature Climate Change* 4:1045

Cherubini, F., Guest, G. and Stromman, A. (2012). Application of Probability Distributions to the Modeling of Biogenic CO2 Fluxes in Lifecycle Assessment. *Global Change Biology Bioenergy* 1 - 15.

Cintas, Olivia, Göran, B., Cowie, A., Egnell, G., Holmstrom, H., Marland, G and Ågren, G. (2017). Carbon balances of bioenergy systems using biomass from forests managed with long rotations: bridging the gap between stand and landscape assessments. *Global Change Biology Bioenergy*. Retrieved from doi: 10.1111/gcbb.12425, 2017

Galik, C.S. and Abt. R.C. (2012). The effect of assessment scale and metric selection on the greenhouse gas benefits of woody biomass. *Biomass and Bioenergy* 44:1–7.

Galik, Christopher S, and Robert C. Abt. (2012). "The Effect of Assessment Scale and Metric Selection on the Greenhouse Gas Benefits of Woody Biomass." *Biomass and Bioenergy* 44 (September): 1–7. doi:http://dx.doi.org/10.1016/j.biombioe.2012.04.009.

Commented [LSM3]: It is not apparent which of these is in the text at the two points they occur. Maybe a 2012a and 2012 b?

IPCC (Intergovernmental Panel on Climate Change). (2007). *Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007.* Cambridge, United Kingdom and New York, NY. Retrieved from [HYPERLINK "http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf"].

Jonker, Jan G.G., Junginger, M. and Faaij, A. (2014). "Carbon Payback Period and Carbon Offset Parity Point of Wood Pellet Production in the South-Eastern United States." *Global Change Biology Bioenergy* 6 (4): 371–89. doi:10.1111/gcbb.12056.

Lamb, B.K., Cambaliza, M.O.L., Davis K.J., Edburg, S.L., Ferrara, T.W., Floerchinger, C., Heimburger, A.M.F., Herndon, S., Lauvaux, T., Lavoie, T., Lyon, D.R., Miles, N., Prasad, K.R., Richardson, S., Roscioli, J.R., Salmon, O.E., Shepson, P.B., Stirm, B.H. and Whetstone, J. (2016) Direct and Indirect Measurements and Modeling of Methane Emissions in Indianapolis, Indiana *Environmental Science and Technology*. 50: 8910-8917

Mitchell, Stephen R., Harmon, M.E. and O'Connell, K.E.B. (2012). "Carbon Debt and Carbon Sequestration Parity in Forest Bioenergy Production." *GCB Bioenergy* 4 (6): 818–27. doi:10.1111/j.1757-1707.2012.01173.x.

ED_004741_00008927-00032

National Council for Air and Stream Improvement. (2015). Comment to the Biogenic Carbon Emissions Panel of the EPA Science Advisory Board. August 5, 2015. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/254A0104C4745E5785257E98006493E4/$File/NCASI+comments+for+Aug.+6,+2015.pdf"]

Commented [LSM4]: I cant find this in the document – there is a portion that talks avout NCASI's comments in 2011, though.

Ocko, I.B., Hamburg, S.P., Jacob, D.J., Keith, D.W., Keohane, N.O., Oppenheimer, M., Roy-Mayhew, J.D., Schrag, D. P. and Pacala, S.W. (2017) Two-valued Global Warming Potential Effectively Captures Long- and Short-term Climate Forcing. *Science.* 356:492-493

Shoemaker, J.K., Schrag, D.P., Molina, M.J. and Ramanathan, V. (2013). "What Role for short-Lived Climate Pollutants in Mitigation Policy?" *Science* 342: 1323-1324.

Ter-Mikaelian, Michael T., Colombo, S.J. and Chen, J. (2015). "The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions? A Review of Common Misconceptions about Forest Carbon Accounting. " *Journal of Forestry* 113 (1): 57–68.

U.S. EPA (Environmental Protection Agency). (2011). *Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources.* Office of Atmospheric Programs. Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886/$File/Biogenic_CO2_Accounting_Framework_Report_LATEST.pdf.

U.S. EPA (Environmental Protection Agency). (2014). *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources.* Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf//LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252/$File/Framework-for-Assessing-Biogenic-CO2-Emissions+(Nov+2014).pdf.

U.S. EPA (Environmental Protection Agency). (2015). *Response to the SAB Panel Peer Review Advisory*. Retrieved from SAB Biogenic Carbon Emissions Panel Meeting Webpage. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/SABPRODUCT.nsf/5295DAC6053510F285257DFD0075C181/$File/OAR+Response+to+SAB's+2012+Advice.pdf"].

U.S. EPA SAB (U.S. EPA Science Advisory Board). (2012). *SAB Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources*. Retrieved from SAB website : [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf"].

Walker, Thomas, Cardellichio, P., Colnes, A., Gunn, J., Kittler, B. Perschel, B., Recchia,C. and Saah, D. (2010). "Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources." Manomet Center for Conservation Sciences, no. June: 182. doi:NCI-2010-03.

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APPENDIX A: CHARGE TO THE SAB

February 25, 2015

MEMORANDUM

To: **Holly Stallworth, Designated Federal Official**
Science Advisory Board Staff Office

From: Paul Gunning, Director
Climate Change Division

Subject: **Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources and Charge Questions for SAB peer review**

The purpose of this memorandum is to transmit the revised *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources,* related documentation and charge questions for consideration by the Science Advisory Board (SAB) during your upcoming peer review.

In January 2011, the U.S. Environmental Protection Agency (EPA) announced a series of steps it would take to address biogenic CO_2 emissions from stationary sources. EPA committed to conduct a detailed examination of the science and technical issues related to assessing biogenic CO_2 emissions from stationary sources and to develop a framework for evaluating those emissions. The draft study was released in September 2011 and subsequently peer reviewed by the SAB Ad-Hoc Panel on Biogenic Carbon Emissions (SAB Panel). The final peer review report was published September 2012.

To continue advancing the agency's technical understanding of the role that biomass use can play in reducing overall greenhouse gas emissions, the EPA released a second draft of the technical report, *Framework for Assessing Biogenic Carbon Dioxide for Stationary Sources*, in November 2014. This revised report presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions. The revised report takes into account the SAB Panel's peer review recommendations on the draft 2011 Framework as well as the latest information and input from the scientific community and other stakeholders.

The revised framework addressed many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis, including an alternative fate approach for waste-derived feedstocks and certain industrial processing products and byproducts; an evaluation of tradeoffs from using different temporal scales; an improved representation of the framework equation; and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales.

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We ask the SAB to review and offer recommendations on specific technical elements of the revised framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions, as identified in the charge accompanying this memo. We look forward to the SAB's review.

Please contact me if you have any questions about the attached study and charge.

Attachments:

1) *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*
2) Technical Appendices
3) Response to the 2011 SAB Panel Peer Review Advisory

Peer Review Charge on the Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

To improve the quality, utility, and scientific integrity of the Framework, EPA is providing this study, *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (November 2014) and related materials to the Science Advisory Board (SAB). The revised report takes into account the SAB Biogenic Carbon Emissions Panel's ("SAB Panel") peer review recommendations[2] on the draft 2011 Framework[3] as well as the latest information and input from the scientific community and other stakeholders. The "Response to SAB" document included in the materials provided for this review discusses and responds to the SAB Panel key points and recommendations, serving as a guide to how the revised framework incorporates their recommendations. This charge narrowly focuses on a few specific remaining questions that were not explicitly addressed in the initial SAB Panel peer review report.

The revised 2014 framework report identifies key scientific and technical factors associated with assessing biogenic CO_2 emissions from stationary sources using biogenic feedstocks, taking into account information about the carbon cycle. It also presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions.

The revised framework and the technical appendices address many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis (Appendices J-L); an alternative fate approach for waste-derived feedstocks (Appendix N); and certain industrial processing products and byproducts (Appendix D Addendum); an evaluation of tradeoffs from using different temporal scales (Appendix B); an improved representation of the framework equation (Appendix F); and illustrative case studies demonstrating how the framework equation can be applied, using region-

[2] The final peer review report from the SAB Panel on the draft 2011 framework was published on September 28, 2012 (Swackhamer and Khanna, 2011). Information about the SAB peer review process for the September 2011 draft framework is available at [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886"].

[3] The 2011 *Draft Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources* is available at [HYPERLINK "http://www.epa.gov/climatechange/ghgemissions/biogenic-emissions.html"].

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feedstock combinations to generate regional defaults per different baseline approaches and temporal scales (Appendices H-N).

As explained in the revised framework introduction and accompanying SAB response document, the revised framework maintains the policy neutral approach from the 2011 draft Framework. It is a technical document that does not set regulatory policy nor does it provide a detailed discussion of specific policy and implementation options. Ultimately, the framework provides a methodological approach for considering, and a technical tool (the framework equation) for assessing, the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources. The revised framework details technical elements that should be considered as appropriate per specific policy applications or biogenic carbon-based feedstock assessments. Therefore, this charge excludes policy and regulatory recommendations or legal interpretation of the Clean Air Act's provisions related to stationary sources.

The revised report does not provide any final values or determinations: it offers indications of different biogenic feedstock production effects per research and analyses conducted, including illustrative example results per specific case study parameters. As discussed by the previous SAB Panel, this report also finds that biophysical and market differences between feedstocks may necessitate different technical approaches. Even using a future anticipated baseline approach, forest- and agriculture-derived feedstock characteristics, and thus analyses and results, may vary per region and per feedstock, and may be influenced by land use change effects. Illustrative analyses conducted for specific waste-derived feedstock case studies using a counterfactual anticipated baseline, as recommended by the SAB Panel, yielded minimal or negative net emissions effects.

This charge focuses on questions that remain regarding whether there are more definitive technical determinations appropriate for parameterizing key elements of the revised framework, regardless of application to a specific policy or program. Specifically, we ask that the SAB Panel examine and offer recommendations on future anticipated baseline specification issues in the context of assessing the extent to which the production, processing, and use of forest- and agriculture-derived biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions – such as appropriate temporal scales and the scale of biogenic feedstock usage (model perturbations or 'shocks') for analyzing future potential bioenergy production changes.

Technical approaches, merits and challenges with applying a future anticipated baseline

Establishing a baseline creates a point of comparison necessary for evaluating changes to a system.[4] Baseline specification can vary in terms of what entity or groups of entities are being analyzed (e.g., industries, economic sectors), temporal and spatial scales, geographic resolution, and, depending on context, environmental issues/attributes (EPA, 2010).[5] The choice of baseline approach can also depend

[4] Definitions for baseline vary, including "the reference for measurable quantities from which an alternative outcome can be measured" (IPCC AR4 WGIII, 2007) or "the baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines" (IPCC AR4 WGII, 2007).

[5] Guidelines for Preparing Economics Analyses (NCEE), Chapter 5: [HYPERLINK "http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-05.pdf/$file/EE-0568-05.pdf"]

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on the question being asked and the goal of the analysis at hand. For example, some GHG analysis may require a baseline against which historic changes of landscape carbon stocks can be measured. Other applications may necessitate a baseline against which the estimated GHG emissions and sequestration associated with potential future changes in related commodity markets and policy arenas. Analyses of the estimated GHG emissions and sequestration effects from changes in biomass use have used different baseline approaches, as well as a wide range of different temporal scales and alternative scenario parameters (Sohngen and Sedjo, 2000; Fargione, 2008; UNFCCC, 2009; Walker et al., 2010; Cherubini et al, 2011; Galik and Abt, 2012; Latta et al., 2013; Walker et al., 2013; AEO, 2014; U.S. EPA, 2014; Miner et al., 2014).

The draft 2011 framework had discussed three different potential baseline approaches – reference point, future anticipated and comparative – and used the reference point baseline in its hypothetical case study applications of the Framework. The SAB Panel in its review stated that "the choice of a fixed reference point may be the simplest to execute, but it does not actually address the question of the extent to which forest stocks would have been growing/declining over time in the absence of a particular bioenergy facility" (SAB Advisory, p. 29). The SAB Panel expressed concern that the reference point baseline does not address the important question of additionality, or what would have been the trajectory of biogenic CO_2 stocks and fluxes in the absence of an activity or activities using biogenic feedstocks for energy, especially in the context of forest-derived feedstocks.[6] "Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach" (SAB Letter, p. 2).

Through public comments to the SAB Panel during the 2011-2012 SAB peer review process, various stakeholders expressed divergent perspectives on the appropriate baseline for the draft 2011 framework report.[7] The revised 2014 framework retains the reference point baseline and adds the anticipated baseline in order to retain adaptability for potential applications, and discusses both approaches at length in the revised report and several technical appendices. However, as the SAB Panel was clear in its previous review of the reference point baseline, EPA has no outstanding technical questions for the SAB Panel on that baseline approach. This charge focuses specifically on remaining technical questions that EPA has on the future anticipated baseline approach.

Part 1 – Future anticipated baseline approach and temporal scale

[6] The difference in net atmospheric CO_2 emissions contributions with and without changes in biogenic feedstock use is known as additionality (Murray et al., 2007). Additionality can be determined by assessing the difference in potential net atmospheric CO_2 emissions of a specific level of biogenic feedstock use over a certain period of time (in many cases the business-as-usual [BAU] baseline) versus the net atmospheric CO_2 emissions contributions that would have occurred over the same time period with a different level of biogenic feedstock use (counterfactual scenario), holding other factors and assumptions consistent between scenarios.

[7] The American Forest and Paper Association (AF&PA) supported the reference point baseline (e.g., comments submitted October 2011, March 2012) applied historically (January 2012, March 2012). The National Alliance of Forest Owners (NAFO) stated if certain feedstocks weren't categorically excluded, then the historical reference point baseline should be used (e.g., March 2012, August 2012). The U.S. Department of Agriculture stated preference for a historic baseline approach (May 2012). The Environmental Defense Fund (EDF) (January 2012, May 2012) and NCASI (October 2011, March 2012) both supported the retrospective reference point approach, though also both offered recommendations if an anticipated baseline approach was included (EDF for future anticipated and NCASI for counterfactual). Others, such as Green Power Institute (March 2012), the National Resource Defense Council (NRDC, August 2012), Becker et al. (August 2012), Biomass Energy Resource Center et al. (February 2012), and a group scientists letter to EPA (June 2014) all support some form of the anticipated baseline approach (future anticipated and/or counterfactual).

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It is important to consider possible treatments of time and the implications of these treatments in developing strategies for long-term and short-term emissions assessment, because the choice of treatment may have significant impacts on the resultof an assessment framework application. For the intended use of the revised Framework – assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions – there are different elements of time to consider when using a future anticipated baseline approach. These elements can include:

- Emissions horizons, assessment or policy horizons, and reporting periods (i.e., fluxes related to feedstock production may occur over many years to decades, whereas reporting may be the current year and policies may cover only a few years or decades), and
- Differences in temporal characteristics of different feedstocks (i.e., annual crops, short rotation energy crops, and longer rotation forestry systems).
- Changes in biophysical and economic conditions over time may affect or differ from those in future anticipated baseline and scenario estimates.

The SAB Panel in its previous peer review noted that "this is a complicated subject because there are many different time scales that are important for the issues associated with biogenic carbon emissions" (Advisory, page 13). They discussed multiple temporal scales associated with mixing of carbon throughout the different reservoirs on the Earth's surface at the global scale (Advisory, page 13) and climate responses to CO_2 and other greenhouse gases (Advisory, page 15), implications of temporal scales greater and shorter than 100 years, and those related to the growth cycles of different feedstock types (Advisory, page 15). The SAB Panel specifically highlighted considerations for using a 100-year or longer temporal scale for evaluating climate impacts and radiative forcing[8] as well as decay rates and carbon storage in forest ecosystems in the main text as well as in Appendices B-D. However, in its recommendations, including those for developing default BAFs per region, the SAB Panel did not offer recommendations per what temporal scale to use in the specific context of the Framework for its intended use and scope. Instead, the SAB Panel stated that "there is no scientifically correct answer when choosing a time horizon, although the *Framework* should be clear about what time horizon it uses, and what that choice means in terms of valuing long term versus shorter term climate impacts (Advisory, page 15) and recommended that a revised framework "incorporate various time scales and consider the tradeoffs in choosing between different time scales" (Advisory, page 43).

Multiple stakeholders have also weighed in on temporal scales, some with specific recommendations on what temporal scale should/could be used for framework assessments, others with no specific recommendations but emphasizing the importance of time. In various comments submitted during the 2011-2012 SAB process, NAFO supported a 100-year timeframe (March 2012). The National Council for Air and Stream Improvement (NCASI) in October 2011 comments suggested "the need for

[8] EPA acknowledges that the long-term climate impacts of shifting from fossil fuel to biogenic energy sources is an important topic for climate change mitigation policy and also recognizes the extensive work being conducted by EPA and throughout the research community on this question. However, EPA's focus here is on a narrower, more targeted goal of developing tools to assess the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic feedstocks at stationary sources. This more narrowly defined assessment is anticipated to be a better fit for the types of program and policy applications in which this framework may potentially be applied.

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considerable flexibility in setting the temporal scales for determining the stability of forest carbon stocks. There are a range of circumstances that can cause transient trends in carbon stocks that can obscure the more relevant long-term picture."

Other groups, such as The Wilderness Society (TWS), NRDC, EDF and others, submitted comments supporting consideration of shorter temporal scales. In its comments and example calculations, TWS (in October 2011 comments) implied support for shorter temporal scales, and stated in later comments that the SAB "text appears biased toward ignoring effects that occur within a 100-year period" (May 2012). NRDC (August 2014) implied support for shorter temporal scales: "even if near-term carbon emissions increases are eventually 'made up' by regrowth over the very long term, the carbon emission from these types of biomass actually exceed those from fossil fuels for decades. This puts use of these types of biomass fuels in conflict with the urgent need for near-term carbon emissions reductions. The time profile of the carbon emission from biogenic fuel sources matters because it is critical to limit near-term global GHG emissions." This perspective was similar to that shared by Becker et al. in their August 2012 comments. EDF (January 2012) suggested a very short temporal scale (in the context of supporting a retrospective reference baseline). Others, such as the Biotechnology Industry Organization (October 2011) simply asked for "clarification on the methodology used to identify the time scale of carbon cycles."

Per the various recommendations above, the revised framework report and the technical appendices include a more detailed discussion of intertemporal tradeoffs inherent in various options for treating emissions over time in the context of assessing biogenic CO_2 emissions from stationary sources. Specifically, the revised report has: a section on key temporal scale considerations (pages 33-38); an appendix dedicated to temporal scale issues (Appendix B), which includes further discussion of temporal scales in the context of future anticipated baselines and decay rates for feedstocks that would have otherwise decayed if not used for energy, and; an appendix describing the background of and modeling considerations for constructing an anticipated baseline approach (Appendix J). Also, illustrative calculations using the future anticipated baseline estimates use future simulations and thereby explicitly incorporate temporal patterns of different feedstocks (e.g., feedstock growth rates, decay rates) into the analysis and shows how results can vary per temporal scale used (as seen in Appendices K and L). The revised framework does not recommend specific temporal scales for framework applications, but rather identifies different elements of and considerations concerning time to provide insights into the potential implications of using different temporal scales.

EPA seeks guidance on the following issues regarding appropriate temporal scales for assessing biogenic CO_2 emissions using a future anticipated baseline, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the previous SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of temporal scale both within and outside of a specific policy context.

Part 1 – Future anticipated baseline approach and temporal scale

1. What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of

biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

a. Should the temporal scale for computing BAFs vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.
    i. If temporal scales for computing BAFs vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?
    ii. Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?
    iii. Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default BAFs versus crafting policy specific BAFs?
b. Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?
c. Should calculation of the BAF include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?
d. What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions *ex post*), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

Part 2 – Scales of biomass use when applying future anticipated baseline approach

EPA seeks guidance on technical considerations concerning how to select model perturbations ('shocks') for future anticipated baseline simulations estimating the net atmospheric contribution of biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework

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could be also be used in specific policy contexts, the questions below relate to the choice of model shocks both within and outside of a specific policy context.

2. What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?
   a. Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
   b. What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?
   c. Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?
   d. Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?
   e. For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).
   f. How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?
   g. Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?
   h. What considerations could be useful when evaluating the performance of the demand shock choice *ex post*, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward

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APPENDIX B: MEMBERS OF THE BIOGENIC CARBON EMISSIONS PANEL

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Dr. Madhu Khanna, ACES Distinguished Professor in Environmental Economics, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Urbana, IL

PANEL MEMBERS

Dr. Robert Abt, Professor of Forestry, Department of Forestry and Environmental Resources, College of Natural Resources, North Carolina State University, Raleigh, NC

Dr. Morton Barlaz, Professor, Civil, Construction, and Environmental Engineering, Engineering, North Carolina State University, Raleigh, NC

Dr. Marilyn Buford, National Program Leader, Silviculture Research, Research & Development, USDA Forest Service, Washington, DC

Dr. Mark Harmon, Professor and Richardson Chair, College of Forestry, Oregon State University, Corvallis, OR

Dr. Jason Hill, Associate Professor, Bioproducts and Biosystems Engineering, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota, St. Paul, MN

Dr. John Reilly, Senior Lecturer and Co-Director, Joint Program on the Science and Policy of Global Change, Center for Environmental Policy Research, E19-439L, Massachusetts Institute of Technology, Cambridge, MA

Dr. Charles Rice, Distinguished Professor, Department of Agronomy, Soil Microbiology, Kansas State University, Manhattan, KS

Dr. Steven Rose, Senior Research Economist, Energy and Environmental Analysis Research Group, Electric Power Research Institute, Palo Alto, CA

Dr. Daniel Schrag, Professor of Earth and Planetary Sciences, Harvard University, Cambridge, MA

Dr. Roger Sedjo, Senior Fellow and Director of the Center for Forest Economics and Policy Program, Resources for the Future, Washington, DC

Dr. Ken Skog, Supervisory Research Forester (retired), Economics and Statistics Research, Forest Products Laboratory, USDA Forest Service, Madison, WI

Dr. Tristram West, Ecosystem Scientist, Joint Global Change Research Institute, University of Maryland, College Park, MD

Dr. Peter Woodbury, Senior Research Associate, Department of Crop and Soil Sciences, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, U.S.A.

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Dr. Holly Stallworth, Designated Federal Officer, U.S. Environmental Protection Agency, Washington, DC

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DATE

EPA-SAB-19-xxx

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Subject: SAB review of *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014)

Dear Acting Administrator Wheeler:

The EPA Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014) ("2014 Framework"). The 2014 Framework considers the scientific and technical issues associated with accounting for emissions of carbon dioxide (CO_2) from biogenic feedstocks used at stationary sources.

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for CO_2 emissions associated with the combustion of biogenic feedstocks at stationary facilities by accounting for the biological carbon cycle effects associated with growth, harvest, and processing of these feedstocks. The BAF is an accounting term developed by EPA to adjust stack emissions to reflect a feedstock's *net* carbon emissions after accounting for subsequent sequestration of carbon in regrown biomass or soil, and after considering emissions that might have occurred with an alternate fate had the biomass not been used for fuel.

The SAB notes that EPA's 20124 Framework may be used to develop BAFs for multiple regulations and associated climate objectives (e.g., total emissions versus temperature, etc.) ~~and resulting regulations,~~ ~~and~~it therefore ~~it~~ must ~~consider~~be able to accommodate a wide range of potential time and spatial scales and ~~-~~all relevant GHGs~~, and policy goals (i.e., total emissions versus temperature, etc.) in order to calculate specific BAFs.~~ Lack of specificity in the BAF objectives to be addressed under the Framework~~applicable to that objective, making~~has made it difficult for the SAB to address many of the charge questions fully.

EPA's 2014 Framework is a revision of its 2011 Framework, which the SAB previously reviewed. The SAB notes that the 2014 Framework incorporated some of the SAB's prior advice and advanced the analytical foundation for making determinations about the net contribution of biogenic feedstocks to CO_2 in the atmosphere. Specifically, the 2014 Framework has incorporated the SAB's prior advice as follows:

- It has adopted an alternative fate approach (i.e., a counterfactual evaluation of what the net biogenic atmospheric contribution might have been if the feedstocks were not used for energy) to the collection and use of waste-derived feedstocks, including avoided methane (CH_4) emissions.
- It includes a discussion of the trade-offs inherent in the selection of a temporal scale for considering net emissions.
- It has developed representative BAFs by feedstock and region rather than facility-specific BAFs.
- It includes a review of existing approaches to addressing leakage, the phenomenon by which efforts to reduce emissions in one place affect market prices that shift emissions to another location.
- It offers an approach to construct an anticipated baseline that allows assessment of the additional CO_2 emissions to, or uptake from, the atmosphere that can be attributed to biogenic feedstocks as a result of changes in biomass feedstock demand.

The 2014 Framework does not, however, provide the ~~policy-~~regulatory context, specific BAF calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. The BAF is a *construct* designed to evaluate the importance of the stack emissions of CO_2 at a given time relative to their climate impacts at some point in the future when some of the emitted CO_2 may have been sequestered by regrowth of biogenic feedstocks. As such, the computation of the BAF for a feedstock in a region depends upon the climate impact of concern and the future point in time that is of interest, which is a choice that depends upon the ~~objective of interest~~specific regulation that will rely on that BAF. If the objective of interest for the BAF computation is defined by short term processes, then the relevant time-period for the BAF computation needs to ~~be consistent~~include relevant details on short term climate phenomena, which might be less important if the objective of interest is much longer term. In addition to ~~providing~~ identifying ~~details on the objective to inform~~ the relevant analytic time frame, ~~a policy regulatory context~~knowing the objectives of interest would ~~have~~ provide~~d~~ other information necessary to the assessment of the science underpinning the BAFs, such as the scale of demand for biogenic feedstocks, ~~and~~ the anticipated time frame for that demand and eligible feedstocks to meet it, relevant spatial scope, and importance of including each type of GHG in the analysis. ~~Policy-Regulatory choices are expected to affect actions taken in feedstock markets, and these anticipated actions affect the assumptions in the models used to compute the BAF.~~

Commented [SA1]: I suggest deleting the last sentence because it does not seem to relate to how the regulatory context affects the scope of the BAF calculation. It is true a factual matter but it does not further the point of this paragraph. Deletion is the easy fix, and it doesn't make a point on its own that seems important to the SAB's evaluation of the framework.

While the SAB agreed with many of the recommendations developed by the Biogenic Carbon Emissions Panel in previous drafts of the report, it disagreed with the extended time frame recommended for BAF computation. There was ~~extended much~~ discussion between the SAB and the Biogenic Carbon Emissions Panel over the significance of the time horizon used to calculate BAFs. The Panel recommended that a general principle for determining the time horizon for BAF calculations should be to select a time horizon that fully accounts for the temporal dynamics for all feedstocks to accommodate the Agency's preference for a regulatory-tion~~policy~~-neutral approach. During quality reviews the SAB disagreed with this recommendation noting that for regulatory~~policy~~ initiatives that focus on objectives that reflect shorter time horizons, a general model with a long time horizon ~~it~~ may not ~~accurately~~ adequately capture the net carbon dioxide emissions relevant to ~~that policy-regulation if a BAF is calculated to incorporate nearly all carbon stock effects over a much longer period of time.~~ the nearer-term outcomes. The SAB favors selecting the time horizon for calculating the BAF to comport with the

objective under consideration, which is generally ~~incorporated into~~dependent on the ~~regulatory policy choice~~regulation mandating use of that particular BAF. The Panel's previous reports remain available on the SAB [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252?OpenDocument"].

As we stated in our 2012 report and we reiterate here: this SAB review would have been enhanced if the Agency offered a specific regulatory application that, among other things, provided explicit proposed BAF objectives, which would in turn ~~calculations and~~ have defined the applicable boundaries regarding upstream and downstream emissions in the feedstock life cycles. The 2014 Framework lacks specificity and is written in a way that is too generic, with too many possibilities that would require assessment of different underlying science. Rather than offering a lengthy menu of calculation options, the EPA Framework needs to define its scenarios and justify those choices. This would enable the SAB to evaluate the science underpinning those decisions and justifications.

Despite this significant limitation, the SAB offers overarching suggestions for moving forward with a framework for assessing the BAFs of biogenic feedstocks. In addition we offer specific responses to EPA's charge questions when possible, the SAB offers general guidance regarding the calculation of BAFs. EPA's equations were based on emissions (fluxes) with some adjustment terms to account for carbon mass escaping the system between the point of assessment and the point of emissions. In the enclosed report, the SAB recommends an alternative formulation based on changes in terrestrial (non-atmospheric) carbon stocks (or pools) such as the live stocks in biomass, dead stocks, soil stocks, etc., that explicitly incorporates the principle of conservation of mass. While the carbon-stock-based accounting system results in a ~~similar~~ formula for BAF similar ~~as~~ to that of ~~the~~ EPA's emissions-based approach, it offers multiple advantages: the component stocks are regularly inventoried and modeled by the scientific community; the different stocks can be aggregated and rearranged as needed or further subdivided; and it is appropriately constrained by conservation of mass and therefore the ~~precision~~ validity of the results can be assessed using mass balance calculations. Although this alternative formulation provides these benefits, other important modeling issues remain. These include selecting appropriate temporal or spatial boundaries, considering variability among classes of feedstocks, accounting for non-CO_2 greenhouse gases such as nitrous oxide and methane, and quantifying stocks and fluxes that are difficult to measure or estimate.

Commented [SA2]: Something is wrong with this sentence, but I don't have enough knowledge of the prior versions to suggest edits to fix it.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for ~~carbon dioxide~~CO_2 related to the use of biomass for electricity generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. We offer this caution about the model boundaries as defined by EPA's method and identified in the SAB review. In addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a whole different analysis and ~~policy~~regulatory policy response.

Commented [SA3]: I think this is one of the few spots where "policy" is more appropriate than "regulatory"

Finally, EPA did not ask the SAB for feedback on its modeling approach. We think this was an oversight, given that modeling is critical to the development of the BAF and different modeling approaches can yield different results. The 2014 Framework employed an integrated model that captures economic and biophysical dynamics and interactions for some of its alternative BAF calculations; however, EPA did not offer explicit justification for its modeling choices derived from articulated criteria. In addition, the sensitivity of BAF responses to some underlying features of the model was not

examined by the EPA or the SAB. Thus, we conclude EPA should identify and evaluate its criteria for choosing a model or models and examine the sensitivity of BAF estimates to key modeling features.

The SAB appreciates the opportunity to provide advice on the 2014 Framework and looks forward to your response.

Sincerely,

Enclosure

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board (SAB), a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The SAB is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names of commercial products constitute a recommendation for use. Reports of the SAB are posted on the EPA Web site at [HYPERLINK "http://www.epa.gov/sab"].

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Acronyms and Abbreviations

AVOIDEMIT	Avoided Emissions
BACT	Best Available Control Technology
BAF	Biogenic Assessment Factor
BAU	Business as Usual
CH4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DOE	Department of Energy
EPA	Environmental Protection Agency
FASOM	Forestry and Agricultural Sector Optimization Model
GHG	Greenhouse Gas
GROW	Term in EPA's BAF equation representing net feedstock growth (or removals)
GWP	Global Warming Potential
PSD	Prevention of Significant Deterioration
N_2O	Nitrous Oxide
SAB	Science Advisory Board
USDA	U.S. Department of Agriculture

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1. EXECUTIVE SUMMARY

The EPA requested the SAB review a revised framework for accounting for biogenic carbon emissions, which the agency defines as "CO_2 emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, digestion, fermentation, decomposition, or processing of biologically based materials."[1] The goal of the 2014 Framework was to evaluate biogenic CO_2 emissions from stationary sources that use biomass feedstocks, given the ability of green plants to remove CO_2 from the atmosphere through photosynthesis. The 2014 Framework and its 2011 predecessor introduced the concept of a Biogenic Assessment Factor (BAF), which is the proposed adjustment for carbon emissions associated with the combustion of biomass feedstocks. The BAF is an accounting term developed in the Framework to denote the offset to stack emissions (mathematical adjustment) to reflect net carbon emissions after taking into account the sequestration of carbon in regrown biomass or soil, as well as emissions that might have occurred with an alternative fate had the biomass not been used for fuel.

Importance of Defining the Objective~~s through the Policy~~~~Regulatory Context~~to Be Addressed by a BAF

The questions before the EPA in 2011 and presented for the SAB's review, were whether and how to consider greenhouse gas (GHG) emissions and decisions about best available control technology (BACT) for CO_2 emissions from biomass feedstocks used for electricity generation at stationary facilities. EPA proposed to address this issue by defining a term, Biogenic Assessment Factor, intended to be used to assess effects *relative* to the desired objectives. The 2014 Framework~~,~~ however, removed the ~~policy~~regulatory context, and did not include specific BAF calculations for any ~~policy~~regulatory context, or the implementation details the SAB previously requested. ~~In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. Thus, evaluation of this construct for a science-based regulatory framework in the absence of the defined objectives is not useful. Rather than assume a set of objectives (articulated in a policy~~regulatory~~ context) or evaluate the charge questions across numerous putative objectives of interest, the SAB focused on providing input on considerations that affect the usefulness and scientific integrity of EPA's approach.~~

~~The SAB notes that~~Because the EPA's 20124 Framework report does not identify the specific metric of climate impact (or "objective") with resulting regulations that a BAF estimate should reflect, ~~and further notes that~~ BAFs that may be developed under the Framework could entail a wide range of objectives, e.g., temporal and spatial domains, total emissions, temperature, etc. While ideally it ~~may~~would be desirable to identify a universal methodology that could be applied to any of a wide range of potential objectives, doing so poses exceptional technical challenges and the concept was not endorsed by the SAB. Thus, the lack of specificity in the 2014 Framework document regarding the objectives that BAFs under it are expected to ~~to be estimated~~addressed makdes it very difficult for the SAB to assess whether the ~~suggested~~ types of models, data, and baselines suggested by the Framework are appropriate, and

Commented [SA4]: My edits here are just to better integrate Larry's new parag (mainly rearranging text within this section) I like the added material by Larry because I think it helps a reader lacking the history of these deliberations to better understand the points that were being made here originally.

Commented [SA5]: I added this based on what I think I've learned from reading sections above -- that the panel was more in favor of this concept than the SAB. If I have this history wrong, my edit here can be removed.

[1] [HYPERLINK "https://19january2017snapshot.epa.gov/climatechange/carbon-dioxide-emissions-associated-bioenergy-and-other-biogenic-sources_.html"]

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~~thus~~has limitsed the ability of the SAB to fully address some of the charge questions. We thus preface the SAB's comments with this observation on the consequences of having made this revised 2014 Framework so ~~general~~unspecific with respect to ~~in~~ its intended and potential applications. The SAB concluded that evaluation of EPA's plan for a science-based regulatory framework in the absence of defined regulatory objectives is not useful. Rather than assume a specific objective, or evaluate the charge questions across numerous putative objectives of interest, the SAB has focused on providing input on considerations that affect the usefulness and scientific integrity of EPA's approach in general.

Region- and Feedstock-Specific Biogenic Assessment Factors, baselines and modeling

As recommended previously by the SAB, BAFs should be feedstock-specific and region-specific and not facility-specific. Facility-specific BAFs are conceptually and practically challenging to estimate due to the absence of well-defined spatial boundaries for feedstock supply to each facility and the role of market-induced effects on land use, on biomass production and market demand for fiber, and on carbon stocks across space. To obtain a region-specific BAF for feedstocks, it is necessary to address region-specific, feedstock-specific demand for biomass and to assess the impact of this increased demand for biomass on net carbon stocks. Changes in demand for biomass feedstocks should be assessed based on historical data on forest carbon stocks, resource use, and observed information on current and planned expansions to facilities using biomass feedstocks. *There is no single answer to what these BAFs should be, as not all biogenic emissions are carbon neutral nor net additional to the atmosphere, and assuming so is inconsistent with the underlying science.*

Projections of the interactions that must be assessed to compute a BAF can be obtained from diverse model types, from simple empirically and statistically-based models, to complex integrated assessment models that combine biophysical and economic factors. ~~The m~~More complex ~~the~~ models may be necessary to capture key economic or physical phenomena required of a BAF, but more complexity can also ~~, the greater the dependence of outputs on input assumptions and available data, which may~~ limit the ~~applicability~~ accessibility of these models to all relevant parties, make them challenging to understand, and make their results difficult to evaluate. This will be a fundamental challenge in developing acceptable BAF estimates for most types of objectives. However, i~~I~~or all model types, sensitivity and uncertainty analyses are needed to adequately interpret the results and understand the dependency of the BAF on the choices and assumptions used as part of its computation.

Commented [SA6]: I feel strongly that the suggestion that complex models are more dependent on assumptions than less complex ones should be eliminated. The rest of my edits here are to fill in the gap with statements about complex models that are valid.

To compare changes in any system over time there must be a reference scenario (without increased demand for biomass feedstocks) against which to assess the net impacts on the variable of interest. In 2012, the SAB recommended a future anticipated baseline approach to capture the *additional* CO_2 emissions to, or uptake from, the atmosphere created by any increased use of biomass feedstocks for electricity generation. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis *along with* a reference point approach in its 2014 Framework. Both the future anticipated baseline and the reference point baseline (with regular updates) are challenging to apply due to data and modeling limitations.

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Regardless of the baseline structure chosen (adjusted reference or future anticipated), validation and evaluation of the model used to compute the BAFs will be critical. Model validation is essential to assessing any model's ability to replicate observed phenomenon over time, ensuring that simulations based on the model are ~~capturing~~ projecting ~~expected~~ logical and reasonable patterns of behavior in the system. Similarly, understanding model sensitivity to input parameters and assumptions is important with respect to assessing model applicability over time. The model selected for estimating BAFs should be reviewed and updated at regular intervals, capturing observed changes in economic and land use conditions that may be due to increased biomass demand or other related conditions, as well as the latest scientific information on biophysical and biogeochemical properties of feedstocks. The appropriate review interval should be selected based on the timeframe of the ~~policy~~regulatory objective(s) as well as the timeframe associated with updates to the underlying data.

Charge Question 1

Temporal and Spatial Scales

A sustained increased demand for biomass feedstocks by stationary facilities in a region is likely to trigger changes in carbon stocks through one or more pathways that could generate a new (steady-state) equilibrium stock of carbon that may be higher or lower than the current stock of carbon on the land. The demand for biomass feedstocks for use in stationary facilities can affect carbon stocks by increasing harvesting intensity for standing biomass, diverting biomass feedstocks from other non-energy products and landfills, converting land from other uses to plant new biomass feedstocks for the future, and utilizing biomass residues that might otherwise decay. Each of these responses may differ over time, and thus, the overall effect of all these responses together on demand for biomass feedstocks may differ over time. Therefore, the time period selected for ~~the analysis can strongly affect the assessed~~estimating the carbon stock or net carbon emissions impacts of an increased demand for biomass feedstocks ~~by stationary facilities on carbon stocks and net emissions of carbon dioxide to the atmosphere~~can strongly affect that estimate. The selection of the time period for assessment is not a purely scientific question, ~~but rather is closely~~and may be driven primarily by ~~associated with~~ the objectives specified in the regulation that mandates use of BAFs to be estimated using this Framework~~policy~~regulatory ~~objectives being addressed by the application of a feedstock-specific and region-specific BAF to a facility(ies)~~. For example, consider an objective to limit peak planetary warming versus an objective of controlling emissions of greenhouse gases in 2050: the same feedstock in the same region could have widely varying impacts on terrestrial carbon stocks because the timeframe defining the endpoint of the relevant analysis would differ. Since BAFs ~~are~~ will computed ~~by assuming~~ to serve specific ~~policy~~regulatory objectives, there are no scientific criteria by which to pick a single 'right' timeframe for their determination independent of their ~~policy~~regulatory context (Ocko et al 2017).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for ~~the~~ this application ~~EPA defines (stationary facility for energy production)~~. A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks.

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Stock-Based Accounting Preferred to Emissions-Based Accounting

Carbon accounting associated with determining BAFs should be based on changes in carbon stocks on the land rather than changes in carbon emissions (as used in EPA's 2011 and 2014 Frameworks). A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated, subject to validation via mass balance and an existing comprehensive system of empirical measurements is already in place for the US. The stock-based approach comports with the current conventions in carbon accounting, which essentially use input-output tracking of carbon throughout a system with well-defined boundaries. These stocks can be aggregated and rearranged as needed, and they are appropriately constrained by conservation of mass and therefore can ~~be assessed and precision determined~~checked for validity using mass balance calculations, in addition to other checks.

policy

Two Cumulative Biogenic Assessment Factor Approaches

The SAB recommends a cumulative carbon accounting metric; however, there are alternative ways to calculate cumulative BAFs. EPA's cumulative BAF (called BAF_T in the 2014 Framework) applied to stocks is one option, reflecting the carbon stocks at the end of the time horizon—specifically, changes in carbon stocks by time, T. One can also calculate a cumulative BAF that is based on the accumulation of annual differences in carbon *stocks* on the land *over the time horizon until equilibrium is reached*, here called $BAF_{\Sigma T}$. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach, i.e., the difference in carbon stocks *at the end of the selected time horizon.*

~~Computing a cumulative BAF over any period of time requires accounting for the positive and negative impacts on stocks over time to determine the net effect on those stocks. A cumulative BAF is preferable to an instantaneous (or annual) BAF because the use of biomass feedstocks can cause changes in carbon stocks that manifest beyond the period in which the feedstock is consumed by a stationary facility. There are two alternative approaches to calculating a cumulative BAF and the implications of these different approaches should be further considered. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach as applied to stocks, i.e., the difference in carbon stocks *at the end of the selected time horizon.* A second approach was developed by members of the Biogenic Carbon Emissions Panel; it considers the time course of CO_2 emissions by accumulating the annual differences in carbon stocks on the land *over the time horizon until equilibrium is reached.* By accumulating annual differences across the projection period, the alternative cumulative BAF metric (which the panel designated as $BAF_{\Sigma T}$) attempts to incorporate "residence time" in the sense that it is a proxy for the length of time carbon stays in the atmosphere until it is modified by changing stocks of carbon on the land. While intended to generate a single BAF term at the end of the selected time horizon, either computation can be evaluated at any time of interest.~~

Commented [SA7]: It seems an entire section was deleted here between Sunday evening's draft and Larry's version. I've just copied it back in below from the Sunday version, and I've made no edits to it from the Sunday night version. I think Larry had said he was going to try to clarify this parag a bit, but if so, we'll need to get them from him – they aren't in this version.

Charge Question 2

Scales of Biomass Use and Modeling Approach

Projections for aggregate demand for all biomass changes should be bounded by historical data on resource use, observed information on current and planned expansions to facilities using biogenic feedstocks, and reasonable projections of cost-effective deployment of biomass feedstocks for meeting the energy/feedstock needs of stationary facilities.

In addition, regular retrospective evaluations of observed levels of demand and the mix of feedstocks would enable revisions to EPA's estimates of feedstock demand. Retrospective evaluations of BAF performance will be important for understanding how effective the modeling has been in predicting what occurred. Thus, projections about biomass feedstock demand should be revised based on actual observations, and these updated demands should be used to inform modeling that generates BAFs.

Recommendations

~~1.~~ As we have observed above, a sound~~An accurate~~ biogenic carbon accounting approach ~~utilizing~~for estimating BAFs ~~Biogenic Assessment Factors~~ will ~~vary~~ depend~~ing~~ on the specific regulatory ~~-~~objectives for those BAFs, which are yet to be defined. Recognizing this limiting factor in the SAB's ability to review the 2014 Framework, we make the following recommendations ~~for their development, which depend upon the policy~~regulatory ~~context, particularly in selection of the time horizon and geographic scope~~.

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~~2.~~ 1 EPA should identify and evaluate its criteria for choosing a model and modeling features that affect BAF results. EPA should explore the sensitivity of BAFs to different modeling approaches, assumptions, transaction costs, and uncertainties in model input parameters.

~~3.~~ 2. Stationary facilities require a continuous supply of biomass feedstocks, thus a landscape approach is appropriate and likely most reliable ~~required~~ for accounting for the impacts of feedstock demand on carbon stocks.~~2~~

~~4.~~ 3. The estimate of the direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no ~~single~~ optimal time horizon for evaluating these impacts, and it may be primarily determined by the regulation mandating use of BAFs.

~~5.~~ 4. Changes in carbon stocks (e.g., live and dead biomass, soil, products, material lost in transport and waste), should be used to account for biogenic carbon, rather than an emissions (flux-based) approach.

~~6.~~ 5. The SAB suggests exploration of two cumulative BAF metrics. Until the implications of the different metrics are clear, the SAB recommends using the metric proposed by EPA, i.e., net changes in stock over a specified time.

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2. INTRODUCTION

2.1. Background

EPA's Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (U.S. EPA 2014).

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for CO_2 emissions associated with the use of biogenic feedstocks in stationary facilities, taking into account the biological carbon cycle associated with the growth, harvest, and processing of plant biomass. This mathematical adjustment to stack emissions is needed because of the unique ability of biological systems to sequester CO_2 from the atmosphere through photosynthesis in living biomass, to sequester carbon in dead biomass and soil, and to release CO_2 through respiration and biologically-mediated decay of organic matter. These attributes of ecosystems mean that there can be wide variation in the net effect of using biomass feedstocks in stationary facilities on emissions of carbon dioxide to the atmosphere and thus it is scientifically indefensible to assume all bioenergy has no net carbon dioxide emissions to the atmosphere, or the reverse, that all emissions represent a net addition to the atmosphere. The ~~Biogenic Assessment Factor~~BAF is an accounting term developed in the Framework to estimate the net CO_2 emissions to the atmosphere over a specified period of time associated with burning biomass feedstocks to produce energy. These net emissions reflect the changes in carbon stocks of above and below ground biomass (live and dead), soils, and wastes. The 2014 Framework is a revision of the 2011 Framework (U.S. EPA 2011), which the SAB previously reviewed (U.S. EPA SAB 2012).

The EPA's charge to the SAB (Appendix A) requests advice and recommendations on its revised 2014 Framework, which was developed with consideration of the SAB's 2012 recommendations as well as the latest information and input from the scientific community and other stakeholders. The EPA asked the SAB to review and offer recommendations on specific technical elements of the 2014 Framework for assessing the extent to which the production, processing, and use of biogenic feedstocks at stationary facilities results in net emissions of CO_2 to the atmosphere so that it could be quantified through calculation of a BAF. ~~The 2014 Framework does not, however, provide the policy/regulatory context-specific Biogenic Assessment Factor calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks.~~

Commented [SA8]: just moving this text to integrate it with Larry's added parag below.

To conduct the present review, the SAB Staff Office reconstituted the Biogenic Carbon Emissions Panel (Appendix B), which had reviewed the 2011 Framework. That panel met multiple times between March 2015 and August 2017. The Panel presented a draft report (February 2016) to the SAB for quality review. The SAB quality review was conducted in March 2016; this quality review resulted in requested revisions from the Panel. The revised draft report (June 2017) was reviewed by the Board in 2017. The 2017 revision of the report was not approved by the SAB based on the deliberations of the quality review. The present report is a product of SAB's direct efforts and utilizes portions of the Panel's report. Previous drafts of the Panel's report are retained on the SAB website and available [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/3235dac747c16fe985257da90053f252!OpenDocument&TableRow=2.2" \l "2."].

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The 2014 Framework does not provide the regulatory context, specific BAF calculations for that context, or the implementation details the SAB requested in its review of the 2011 Framework. That is, ~~The SAB notes that~~ EPA's ~~2012~~ Framework report does not identify the specific metric of climate impact (or "objective") that a BAF estimate should reflect, and further notes that BAFs that may be developed under the Framework could entail a wide range of objectives, depending on the regulation or policy-specific approach that would require use of a BAF. (For example, some regulations may impose objectives related to different time horizons than others; similarly, under some regulations the BAF may need to address a temperature impact objective, while other regulations may impose a net CO_2 emissions objective.) Any BAF must be estimated using a model that has the scope and temporal detail necessary to simulate the key economic, emissions and atmospheric phenomena relevant to predicting that BAF's objective. Lack of specificity in the Framework document regarding the objectives to be estimated makes it very difficult for the SAB to assess whether the suggested types of models, data, and baselines are appropriate. While it would, in this situation, be desirable to identify a universal modeling methodology that could be applied to any of a wide range of potential objectives, this poses significant new analytical and data challenges on the Framework, and the SAB is not endorsing such an approach. Thus, we note as a preface to this set of SAB comments that a consequence of having made the 2014 Framework so general in its potential applications is that it has ~~It also~~ limited ~~the ability of the~~ SAB's ability to fully address ~~some of~~ the charge questions presented to it for this review. ~~We thus preface the SAB's comments with this observation on the consequences of having made this revised 2012 Framework so general in its potential applications.~~

3. OVERARCHING COMMENTS

This section addresses issues that lie outside the scope of EPA's charge questions, but which the SAB considered critical to place the responses to the charge questions in context. The charge questions are narrowly focused on specific technical aspects in the structure of the 2014 Framework. However, the SAB had important general advice regarding the Framework. This first section outlines that advice.

3.1. Defining Objectives through the ~~Policy~~Regulatory Context

For its review of the 2011 Framework, the SAB requested and was given a ~~policy~~regulatory context for use of BAFs that would result from the biogenic CO_2 accounting framework. The SAB was told that the 2011 Framework was intended to guide the determination of CO_2 emissions from regulated stationary sources under the Clean Air Act, specifically those facilities receiving a prevention of significant deterioration (PSD) air permit and that were required to conduct a best available control technology (BACT) analysis for CO_2 emissions. The question before the agency, and hence the SAB, was whether and how to consider biogenic greenhouse gas (GHG) emissions in reaching thresholds for permitting and decisions about BACT for CO_2 emissions from the use of bioenergy in stationary facilities.

The agency has removed this ~~policy~~regulatory context from its 2014 Framework, and the EPA's charge questions seek ~~general~~ guidance on issues related to the choice of temporal, spatial and production scale for determining BAFs in a ~~policy~~regulatory-neutral context. In the absence of a specific ~~policy~~regulatory context, which would ~~provide~~ define the objectives ~~against~~ that ~~which the~~ a BAF ~~will be evaluated~~must estimate, ~~this~~ the SAB limited its review ~~was limited~~ to providing general comments about how to consider the questions posed. More specific answers to the questions posed will vary with the objective (as defined by the ~~policy~~regulatory context), most notably the appropriate time period over which to determine the net biogenic emissions, and to a lesser degree, the appropriate geographical scale for consideration.

A ~~policy~~regulatory context with explicit objectives would clarify if the ~~proposed~~ procedures for determining the BAF will need to account for the emissions of all greenhouse gases that alter the climate. If this is the case, then it will be important that the analytic methods described by the Framework ~~to~~ account for the effect of biogenic feedstocks on non-CO_2 gases such as N_2O and CH_4 and ~~,~~ to examine how the emission or uptake of these gases differ across space, time, and feedstocks~~, and to examine how these gases influence BAFs~~. Given the large difference in the mean residence time of these gases in the atmosphere, their relative importance can vary widely over different time horizons. If ~~the~~ climate impacts over 20 or 40 years ~~is of concern~~is the objective, then methane and carbon particulate emissions could be very important, while if the objective's period of concern is hundreds of years, their importance will drop significantly (Shoemaker, et. al., 2013). Non-CO_2 gases are particularly important for feedstocks grown with nitrogen fertilizer and for waste materials from landfills.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for carbon dioxide related to the use of biomass in stationary facilities for energy generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. If, for example, biomass pellets were sourced from old growth forests, this would pose unique risks that would not be reflected in a BAF calculated for net effects on carbon dioxide. We offer this

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caution about the model boundaries as defined by EPA's method and identified in the SAB review. In addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a different analysis and ~~policy~~regulatory response.

Recommendation

- ~~Biogenic Assessment Factors~~BAFs will vary depending on their specific objective~~s for their development~~, which will depend upon the ~~policy~~regulatory context, particularly in selection of the time horizon and geographic scope. Thus, future efforts to define specific biogenic accounting factors should be conducted in a ~~policy~~regulatory-specific context, with the objectives and relevant time frame specified.
- It is inappropriate to use default assumptions, including assuming there are no net emissions or that all emissions are additive.

Commented [SA9]: This seems like a separate recommendation, so suggest separating it into a sencond bullet.

3.2. Baseline Approach

To compare change in any system over time, there must be a baseline scenario against which to assess changes, in this case, changes due to demand for biogenic feedstocks; a baseline allows different scenarios to be compared. In the 2011 Framework, the EPA assesses the estimated net change in land-based biogenic CO_2 fluxes and/or carbon stocks between two points in time, with the first time point called the reference point. In the 2012 SAB report, we noted temporal problems with the reference point baseline approach. The EPA has acknowledged this in its 2014 Framework and included a future anticipated baseline analysis alternative along with a reference point baseline approach. The 2014 framework notes that the choice of baseline (reference point or anticipated) depends on the question to be answered and the specific context in which the framework is applied.

The SAB's 2012 advice on the anticipated baseline approach explored the use of complex modeling in order to try to capture interactions among the market, land use, investment decisions, and emissions and ecosystem feedbacks, and to construct a counter-factual scenario that does not include increased bioenergy use. In the case of long rotation feedstocks, biomass feedstock demand can affect carbon stocks in many ways including the age of trees harvested, the diversion of forest biomass from traditional forest product markets to bioenergy, and the rates of afforestation and deforestation. Estimating the net effect of these changes on carbon stocks requires a model that integrates market demand and supply conditions with biophysical conditions that determine growth of forest biomass, losses via decomposition, carbon sequestration and fluxes due to harvests and land use change and incorporates the spatial variability in these effects across the U.S. The complexity of such a modeling approach can make it difficult to parameterize and validate, and thus ~~poses a significant challenge for use in any context. Extra effort will be needed to provide the public with thorough and requires a~~ sensitivity ~~analysis~~ analyses of parameters and model assumptions, and explicit recognition of model uncertainties in resulting BAF estimates. ~~The lack of empirical data regarding many of these relationships and the resulting uncertainties poses a significant challenge to use of this type of model in a regulatory context.~~

Also, consistent with the SAB's 2012 recommendations, the EPA has now moved toward a "representative factor" approach that would include an assessment of the biogenic landscape attributes

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(type of feedstock, region where produced). The EPA initially considered calculating a BAF for an individual stationary facility; however, the data needs for a facility-specific approach are daunting if they are to be accurate (e.g., case-specific measurements and calculations of carbon stocks and chain-of-custody carbon accounting, integration of land use changes on a broader landscape level). EPA's use of a representative factor approach is an advance in its accounting methodology, although overly-broad feedstock categories may not reflect important extant or likely future variation in feedstock production or processing (e.g., roundwood in the Southeast, logging residues in the Pacific Northwest, and corn stover in the Corn Belt). The overall approach is a positive development, but caution is required to ensure such inclusiveness does not produce unintentionally negative outcomes, e.g. feedstocks with large net emissions to the atmosphere lumped together with those with more limited net emissions. The EPA should evaluate the "representativeness" of the factors and refine the approach over time with additional data.

As stated in the SAB's 2012 report, there are tradeoffs between ease of implementation (transaction costs), ~~precision generalizability~~ (getting it right at every location), accuracy (getting the overall stock change correct), and ~~policy~~regulatory effectiveness (ensuring that the ~~policy~~regulatory objectives are being met). The SAB continues to recognize the difficulty of undertaking the recommended anticipated future baseline approach, and practicality should be an important consideration in the agency's decision making. While the reference point baseline approach has significant limitations as noted in the SAB's 2012 report, these might be ~~overcome mitigated~~ if regular updating with empirical data to capture regional carbon stock changes (increases or decreases) were employed. All methods considered should be subject to an evaluation of the costs of implementation and compliance and weighed against any increase in accuracy ~~and precision~~ that they might yield. Ultimately it is critical that there is a balance among these considerations~~between accuracy and minimization of implementation costs~~.

Commented [SA10]: was "precision" exactly the word use int he 2012 report for "getting it right at every location"? If so, my suggested rewording cannot be used, but that is sure not the definition of "precision".

Recommendation

- The EPA should identify and evaluate its criteria for choosing a model and its underlying assumptions with regards to how these criteria and assumptions affect the robustness and reliability of calculated representative BAFs. In addition, the EPA should periodically update and validate the selected model to incorporate the latest scientific knowledge while ensuring that the model outputs are consistent with empirical observations (e.g. shifts in measured carbon stocks as determined the Forest Inventory Analysis program). Any model chosen should be subject to sensitivity analysis to evaluate its efficacy under different conditions and to identify data needs and prioritize future research.

3.3. Alternative Fate Approach for Waste-Derived Feedstocks

In 2012, the SAB recommended that the EPA consider alternative fates (i.e., if not used as fuel for electricity generation or process heat) of waste-derived feedstocks diverted from the waste stream, e.g., whether these feedstocks might decompose over a long period of time, whether they would be deposited in anaerobic landfills, whether they would be diverted from recycling and reuse, etc. In the 2014 Framework, the EPA has conducted extensive alternative fate calculations; however, the agency drew a narrow boundary around point source emissions and neglected other significant considerations that affect the GHG footprint of alternative municipal solid waste management scenarios. Specifically, the EPA neglected to quantify a potential alternative fate of municipal solid waste through landfill-derived

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methane combustion. Under the Clean Air Act New Source Performance Standards, the EPA requires landfills above a certain size to, at a minimum, collect and control landfill gas (e.g., through flaring or use). As such, a baseline of direct venting is misleading, although almost all these facilities are likely to produce large emissions of methane, even when in compliance with current regulations (Lamb et al 2016: [HYPERLINK "file:///C:\\Users\\tcarpent\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\9EYAZ1S8\\www.epa.gov\\lmop\\basic-information-about-landfill-gas"]). The relative rankings of BAFs across waste treatment options assessed in the 2014 Framework might change considerably if a more complete accounting were undertaken (e.g., energy recovery from landfill-derived methane and combustion of waste, and carbon storage associated with landfills.)

3.4. Temporal and ~~spatial Spatial~~ considerations in Biogenic Assessment Factor Calculations

The goal of the EPA Framework reviewed is to account for effects of biomass feedstocks used for energy generation at stationary facilities on terrestrial carbon stocks. BAFs are a carbon accounting method based on expected future changes in carbon stocks (measured in tons of carbon). They are designed to assess the net contribution of CO_2 from a stationary facility that uses biomass feedstocks, due to shifts of terrestrial carbon to and from the atmosphere over a specified period of time. The time scale selected will vary depending on ~~policy~~regulatory-defined objectives (e.g., reduction of GHG emissions in 2050 or 2100, or minimizing global temperature change resulting from greenhouse gas emissions). Over the selected time period, all greenhouse gas impacts (not just CO_2) – both positive and negative – should be accounted for (as completely as is feasible).

Commented [LSM11]: Maybe limiting global temperature change?

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach for the application EPA defines (stationary facility for energy production). A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and gains that determines carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks. As noted by Cintas et al. (2016), "assessment at the landscape scale integrates the effects of all changes in the forest management and harvesting regime that take place in response to – experienced or anticipated – bioenergy demand. Taken together, these changes may have a positive, negative or neutral influence on the development of forest carbon balances." Landscape level accounting of effects of forest-based feedstocks on carbon stocks can result in a net gain or loss of carbon stocks in the near to medium term; a carbon debt could be followed by a carbon dividend or the other way around.

BAFs are a carbon accounting tool for assessing CO_2 emissions from facilities that consume biomass feedstocks for production of energy and are not life cycle assessments of net greenhouse gas emissions or their climate change effects. The distinction is that not all indirect systemic effects are considered in the BAF, nor are all GHG effects included. We also underscore our caution that the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, ~~policy~~regulatory efforts, market forces, or natural causes. If such monitoring demonstrates

changes that are not included in the model used to develop the BAF, the BAF should be updated to align with the empirical data.

Recommendation

- Stationary facilities require a continuous supply of feedstock, thus a landscape approach is appropriate and likely most reliable ~~required~~ for accounting for the impacts of feedstock demand on carbon stocks.

RESPONSES TO EPA'S CHARGE QUESTIONS

3.5. Temporal/~~Spatial~~ Spatial Scale for Biogenic Accounting

Charge Question 1: What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

There are several key factors that impact the dynamic nature of the BAF for a specific feedstock and region. The first is that the increased demand for biomass feedstocks in a region could potentially be met by a variety of sources obtained from the agricultural and forestry sectors, including annual and perennial agricultural crops, short rotation woody biomass and pulpwood, and crop and forest residues. Any increase in demand might involve using a larger proportion of an existing resource or diversion from non-energy products and landfills, converting land from other uses to growing biomass feedstocks, changing use of existing feedstocks, utilization of residues that would otherwise decay over some period of time. The effect of increased demand for biomass feedstocks on carbon stocks will depend on the mix of these feedstocks demanded and the scale of demand for these feedstocks.

Second, different biomass sources have different effects on carbon stocks over different timeframes. The plant systems, e.g. forests, agronomic systems, producing feedstocks differ in their rate of growth/regrowth, yield, potential to sequester carbon in biomass and soils, decay rates after harvest, and the type of land-use change that accompanies their production. These effects continue after the feedstock has been consumed by a stationary facility. We therefore recommend computing a cumulative BAF over the relevant time horizon. This cumulative BAF would be based on the difference in carbon stocks between a scenario without change (either computed using a reference point or anticipated baseline) and the increased biomass feedstock demand scenario and would vary with the time horizon selected by the objective in the relevant ~~policy~~regulations.

Key principles for calculating changes in the net carbon stocks should include: (1) the positive and negative impacts of demand for biomass over time, (2) a system-wide (landscape and economy) approach to account for direct and indirect effects, and (3) consistency across each region. Selecting different time horizons for different feedstocks being used to meet the same ~~policy~~regulatory objective would be inappropriate as it would yield inconsistent effects.

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Determining the scale of appropriate regions for calculating BAFs will require balancing similarity in the biophysical characteristics, similar growing conditions (growing season length, vegetation type) and economic factors, biomass demand, with ensuring that the edge to volume ratios of the regions are small enough to ensure minimizing incentives to manipulate the movement of biomass feedstocks among regions due to differing BAFs.

To fully account for all positive and negative terrestrial effects over time, we recommend using the "emissions horizon" ~~as described by the 2014 Framework applied~~that is determined to be relevant by the ~~to a~~ specific ~~policy~~regulatory ~~objective~~BAF-mandating regulation. As defined by the EPA, this "emissions horizon is the period of time during which the carbon fluxes resulting from actions taking place today actually occur …" (U.S. EPA 2014). If the objective for a given BAF is to have an effect on greenhouse gas emissions by a certain date, then the impacts aggregated by that date are the relevant metric to assess meeting the objective, and that date is the appropriate time horizon to end the BAF calculation. Accordingly, there is no single time horizon that will effectively address all policies or feedstocks since feedstock net effects are time-dependent and desired objectives for ~~policy~~regulatory changes target different time horizons. The SAB does not support a single time horizon as appropriate for ~~determining~~ estimating BAFs, because the computed values can vary significantly over differing time horizons and different objectives will be met over different time horizons.

The Panel suggested that the time horizon should be the length of time it would take for the effect of increased demand for biogenic feedstock on the carbon cycle to reach a steady-state. This occurs when the difference in carbon stocks between the increased biomass feedstock demand scenario and the business-as-usual scenario is no longer changing or when the difference is approaching an asymptote. This could result in a very long time horizon being selected for the BAF calculation, potentially hundreds of years if all feedstocks across all regions were to be included. The selection of such a time horizon would mean that for ~~policy~~regulatory objectives with shorter time horizons (e.g., meeting a 2050 emissions target), the accounting would not align with relevant effects of biomass feedstock use at stationary sources on the ~~policy~~regulatory objective. Whether it would be appropriate to use a model that can estimate effects over a much longer time horizon to estimate a BAF with a shorter time horizon will depend on whether that model simulates the relevant nearer-term interactions with sufficient detail to produce reasonable estimates of impacts at nearer term (interim) points in time as well as over the longer horizon.

Commented [SA12]: the point of adding this sentence is to make it clear that this discussion about time horizons is about the calculation of the BAF and not about the model that can be used. One of my major concerns on my first review of this document was that the section seemed to be about model horizons, not the time period over wheih a calculation of BAF is made. I will be mollified on my concern if we can add this one sentence.

Several factors determine the difference in carbon stocks between the business-as-usual scenario and the increased biomass feedstock demand scenario. A major factor is the "speed" with which carbon stocks respond after harvest; this can be influenced by several factors: the speed with which a feedstock regrows and can be harvested again, the mix of feedstocks produced, and the rate at which soil carbon stocks change. Thus, the mix of feedstocks used can influence the shape of the curve and when it reaches equilibrium.

Previous studies have shown that estimates of the effects of biomass harvest on carbon stocks depend on the spatial scale of consideration (stand level or landscape level), the initial conditions of carbon stock on the land (e.g., managed forestland, old growth forestland, or agricultural land), the management practices used, and the time horizon over which effects are measured (Walker et al., 2010; Jonker et al., 2014; Mitchell et al., 2012; Galik and Abt, 2012; Ter-Mikaelian et al., 2015). Harvest of an existing forest stand for use as a feedstock results in an immediate reduction of carbon on the site; the amount of

carbon lost at the stand level is directly related to the intensity of the disturbance. At a stand level, harvest followed by regrowth (most US forests regenerate without intervention/planting) usually results in a cycle of loss followed by gain. The amount of carbon regained on the site can vary: in some cases, all is regained, in others only part is regained, and in others, more can be gained than is released.

Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed asynchronously; the order in which losses and gains occur becomes meaningless at the landscape level because both simultaneously occur. Thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs for biomass feedstocks used at stationary sources. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the business-as-usual scenario, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.

Biomass, particularly from forest sources, is also used for producing non-energy products. The demand for biomass feedstocks for energy generation can lead to a diversion of biomass from those products and lead to an immediate reduction in carbon stocks in products. It is also possible that anticipation of future demand for biomass feedstocks by stationary facilities could lead to land conversion, reforestation and retention, or accumulation of carbon stocks in a growing forest. In general terms, the amount of either net loss or net gain of carbon on the landscape is influenced by changes in many factors including those influencing net primary production and removals, and the net effect can be expected to vary over time.

When agricultural feedstocks ~~that~~ are harvested annually from land under continuous production, the time lag between harvest, CO_2 emissions from conversion to energy, and regrowth on land is likely to be close to one year, and the harvested carbon will be fully regained, with no net impact on above-ground carbon stocks. The production of these feedstocks may directly affect carbon stocks below-ground by increasing or decreasing soil carbon stocks relative to the use of the land in the business-as-usual scenario. The demand for biomass feedstocks can also affect carbon stocks by leading to a change in the use of land which could either release carbon stored in the land (for example if permanent grasslands are converted to annual agricultural production) or accumulate carbon on the land (for example through reforestation as annual cropland is converted back to forests).

Recommendation

- The estimate of direction and magnitude of the impact of using biogenic feedstocks in stationary facilities on terrestrial carbon stocks depends on the time horizon considered. There is no ~~single~~ optimal time horizon for evaluating these impacts, and it may be primarily determined by the regulation mandating use of BAF.

Charge Question 1(a): Should the temporal scale for computing biogenic assessment factors vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or

other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.

Charge Question 1(a)(i). If temporal scales for computing biogenic assessment factors vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?

Charge Question 1(a)(ii). Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?

Charge Question 1(a)(iii). Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default biogenic assessment factors versus crafting policy specific biogenic assessment factors?

Charge Question 1(b). Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?

The responses to questions 1(a), 1(a)(i), 1(a)(ii), 1(a)(iii), and 1(b) are combined because these questions all relate to goals or criteria that may affect choices of differing temporal scales for calculating BAFs.

Question 1a asks specifically if the temporal scale for computing ~~Biogenic Assessment Factors~~BAFs should vary by regulatory policy. As noted in the overall response to Charge Question 1 (above), the SAB concludes that the BAF computation should be informed by the ~~policy~~regulatory objectives, ~~particularly~~ including with respect to time.

If there are ~~multiple~~ different objectives in multiple ~~policies~~ regulations mandating use of BAFs (as discussed in charge question 1(a)(i)), there are no overriding scientific principles that can be applied *a priori* to guide alignment ~~among~~ in the tools to be used for calculating BAFs for ~~these multiple~~different objectives.

One could advocate for a host of approaches to selecting a time horizon for evaluation; all would be plausible but not inherently aligned with the objective of the ~~policy~~ regulations being promulgated. At the extremes one could consider only the carbon accounting over the year in which the biomass was combusted; such an approach would mean that almost all feedstocks would be assigned a BAF close to one, representing no net benefit to reducing atmospheric carbon dioxide concentrations. Conversely one could only consider net impacts on the carbon cycle over several hundred years, which would mean for most feedstocks the BAF would be close to zero (assuming steady demand and unchanged rotation lengths thus allowing stocks to come into equilibrium), indicating all biogenic emissions being net beneficial to the atmosphere. Neither of these approaches would align with the most likely objectives of ~~a biogenic accounting framework~~BAFs; however, neither is inherently correct or incorrect.

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The time horizon for consideration of carbon stock changes should be chosen based on the specific objective of a regulation, once it is identified (e.g., minimizing net greenhouse gas emissions over a specified period or temperature increase by a certain date~~), which would be aligned with the policyregulatory goals~~). The SAB makes no assertion regarding the appropriate ~~policy~~regulatory use of the BAF and thus supports no specific time horizon selected independent of a ~~policy~~regulatory ~~objective~~requirement.

Charge Question 1(c). Should calculation of the biogenic assessment factor include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?

Accumulating all effects of the use of a biogenic feedstock over a time horizon is preferred to a marginal or instantaneous ("per period") BAF. (For the purposes of answering this question, the SAB interprets "marginal" to mean "annual" or "per period" so as to distinguish it from the meaning of "marginal" that typically refers to the last unit of emissions or the additional effect of the last unit of biomass.)

As described in the overall response to Charge Question 1 (above), the SAB recommends a cumulative carbon accounting metric; however, there are alternative ways to calculate cumulative BAFs. EPA's cumulative BAF (called BAF_T in the 2014 Framework) applied to stocks is one option, reflecting the carbon stocks at the end of the time horizon—specifically, changes in carbon stocks by time, T. One can also calculate a cumulative BAF that is based on the accumulation of annual differences in carbon *stocks* on the land *over the time horizon until equilibrium is reached*, here called $BAF_{\Sigma T}$. By accumulating annual differences across the projection period, this alternative cumulative BAF metric attempts to incorporate "residence time" in the sense that it is a proxy for the length of time carbon stays in the atmosphere until it is modified by changing stocks of carbon on the land. While intended to generate a single BAF term at the end of the selected time horizon, either computation can be evaluated at any time of interest. Until the implications of the differences are better understood, we support EPA's cumulative BAF approach, i.e., the difference in carbon stocks *at the end of the selected time horizon.*

The choice of an appropriate cumulative BAF should be informed by a scientific assessment of the dynamics of additions to atmospheric carbon stocks as well as the complexities and uncertainties of these determinations, ensuring the accounting is accurate and verifiable. Both cumulative BAFs attempt to capture net changes in biogenic carbon stocks. A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated and are still subject to mass balance.

With either approach to evaluating BAFs, caution is advised with projections into the future. A BAF is inherently based on some type of modeling that employs assumptions about the relationship of variables in the future based on current observations. These assumptions may not be robust in the future. Each BAF will need to be assessed periodically to see if changing conditions warrant a revision (Bucholz et al. 2014).

Carbon accounting for biogenic emissions can ~~either~~ be framed either using differences in carbon emissions to the atmosphere or using differences in carbon stocks on the land. Conservation of mass dictates that any carbon taken from the land (through increased harvests or other disturbances) will

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result, in the near-term, in equivalent increases of carbon in the atmosphere, followed by longer-run changes in ocean and land-based carbon. Thus, these approaches are compatible, but examining changes in stocks is operationally more direct and can be done periodically, rather than requiring continuous measurements to be accurate. However, both approaches should account for changes within the boundaries of the analysis, such as import and export of biogenic feedstocks and other associated products.

Long-Term Trends in Biogenic Assessment Factors

The Panel has suggested that cumulative BAFs might approach zero as T is reached. However, that is only true for $BAF_{\Delta t}$ and not the cumulative BAFs – BAF_T and BAF_{YT}. Mathematically cumulative BAFs are hyperbolic functions once T is reached and have extremely long "tails", representing a period of net CO_2 emissions to the atmosphere.

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An approach to determining a baseline that includes an historical time period could be used to periodically reset a reference baseline based on re-measuring carbon stocks on the landscape using data from existing inventory programs. Carbon stock measurements have been made for more than a half century in the US, offering a robust record of change. This approach could improve the accuracy of the baseline over time; however, as noted above, the preference for use of a reference or future anticipated baseline depends on the objective. Future changes in growth-to-harvest ratios could be used to inform the model assumptions and modify the BAF that would be applicable going forward. This could create long-term incentives for sustainable management of land resources. In any accounting framework that assumes future regeneration and regrowth, it is important to periodically test this assumption against actual data as they become available. If assumptions of future regeneration and regrowth are not supported by observations, adjustments need to be made to models that are used to determine BAFs.

Recommendations

- The SAB recommends formulating BAFs based on changes in carbon stocks (terrestrial pools such as live, dead, soil, products, material lost in transport and waste), rather than an emissions-based (flux-based) approach, because the former comports with conventional carbon accounting, has well-defined boundaries, and follows the conservation of mass.

- The SAB suggests consideration of two cumulative BAFs—that proposed by EPA and an alternative metric that takes into account the changes in terrestrial carbon stocks over time. The appropriate cumulative metric for calculating BAFs will depend on the understanding of the carbon system and climate response for which there is uncertainty.

Charge Question 1(d). What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions ex post), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is appropriate to periodically revise the modeling and the BAFs. The goal of such revisions would be to update underlying economic and biophysical assumptions and modeling trends in light of new data to reduce uncertainty and to increase accuracy of future projections.

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A retrospective comparison would compare model-projected behavior to newly available historical observations and estimates, such as regional feedstock demand, land-use changes (e.g., reforestation, management intensity, forest rotations characteristics and conversion of land to other land uses including dedicated energy crops), and forest carbon measurements and estimates (both level and composition). It would be important to re-examine parameters, functional forms, and other assumptions of the modeling approach as part of an *ex post* evaluation.

3.6. Scales of Biomass Use

Charge Question 2: What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?

Charge Question 2(a). Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
Charge Question 2(b). What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?

The responses to questions 2(a) and 2(b) are combined below because both questions relate to the size of the simulated change in demand for biomass feedstocks. The complexities are large and any predictions on scale of demand shock can only be done effectively in a ~~policy~~regulatory context as they are very challenging to define otherwise.

If the EPA's goal is to obtain a region-specific BAF for a feedstock, it will be necessary to project region-specific and feedstock-specific demand for biomass. Since the BAF for a feedstock could differ depending on the method of production (for example, the soil carbon implications of corn stover will depend on the type of tillage practice used and the amount of residue harvested), it will be appropriate to have the BAF for a feedstock in a region reflect the methods used to produce that feedstock. To the extent that BAFs depend on technology and emissions control regulations at a stationary facility in a region, they could also be defined in terms of specific technologies.

Charge Question 2(c). Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?

In the absence of a specific ~~policy~~regulation to model, the SAB cannot offer general recommendations for a representative scale of demand shock.

Charge Question 2(d). Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?

Charge Question 2(e). For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a

change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).

The responses to questions 2(d) and 2(e) are combined because both questions relate to modeling biomass feedstocks in isolation or jointly.

In the absence of a mandate for use of specific feedstocks or incentives for specific types of bioenergy which might be prescribed in a ~~policy~~regulatory framework, and which would inform the feedstock-specific demand that should be modeled, a reasonable approach is to model the aggregate demand for feedstocks. This approach assumes facilities are constantly seeking their least-cost alternative. An aggregate demand could be imposed on the model and used to determine demand for different feedstocks in different regions. This would allocate demand across feedstocks as well as within each category to simulate a given target aggregate demand determined by the market's ability to draw from the least cost combination of feedstocks.

Charge Question 2(f). How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?

Default BAFs would likely vary by the scale of demand. In fact, a single set of default BAFs is unlikely to be robust across a wide range of scales of demand. The scale of demand is likely to influence the mix of feedstocks that is viable to produce because it can be expected to affect the market price of biomass. Low levels of demand for biomass may be met relatively easily by crop residues, forest residues and mill residues; high levels of demand could lead to dramatically increased harvests of forest biomass or production of dedicated energy crops. The BAF of a feedstock in a region can be expected to vary depending on whether there is a 1-million-ton increase in biomass demand or a 1-billion-ton increase in biomass demand.

In the absence of information about the scale of demand, BAFs could be determined for different threshold levels of aggregate demand for biomass feedstocks and consequent feedstock/region-specific demand.

Charge Question 2(g). Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?

While the methodological framework for different policies could be similar, we expect differences as follows: (1) BAFs that are tied to a particular regulatory ~~policy~~approach, versus a particular period of time, would be based on simulating the aggregate and feedstock-specific demand that is expected to emanate from that ~~policy~~regulation, while ~~policy~~regulatory neutral factors would be based on various exogenously specified quantities of demand for biomass and corresponding endogenously determined levels of feedstock specific demand, and (2) different ~~policies~~ regulations may require different production and use practices, and thus result in different biogenic factors. Isolating the extent to which expected increase in demand for biomass and its consequences for CO_2 emissions can be attributed to a specific ~~policy~~regulation (when there are multiple ~~policies~~ regulations inducing a shift to renewable energy) is likely to be complicated and challenging to convert into ~~policy~~regulatory-specific BAFs. It

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could also create unintentionally negative incentives for feedstock choice to comply with various ~~policies~~regulations.

Charge Question 2(h). What considerations could be useful when evaluating the performance of the demand shock choice ex post, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is likely that the observed feedstock demand in response to a specific ~~policy~~ regulation will differ from the forecast because the ~~policy~~regulation can be expected to increase demand for feedstocks with lower BAF and decrease demand for feedstocks with a high BAF. Since feedstock-specific demand and the feedstock BAFs are likely to be jointly determined, while the approach proposed above determines them sequentially, divergence between model simulated demand for feedstocks and observations is inevitable.

An evaluation using actual data would also allow revisions to the EPA's estimates of feedstock demand changes (as discussed in response to Question 1d) based on updated data. To improve the performance of the model for assessing BAFs retrospectively, quantities of biomass feedstock (by feedstock category) harvested could be updated with actual observations. New data should improve the estimate of the portion of total biomass demand that is attributable to stationary facilities. This information could be used to improve BAFs.

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REFERENCES

Bucholz, T., Prisley, S., Marland, G., Canham, C. and Sampson, N. (2014) Uncertainty in predicting GHG emissions from bioenergy. *Nature Climate Change* 4:1045

Cherubini, F., Guest, G. and Stromman, A. (2012). Application of Probability Distributions to the Modeling of Biogenic CO2 Fluxes in Lifecycle Assessment. *Global Change Biology Bioenergy* 1 - 15.

Cintas, Olivia, Göran, B., Cowie, A., Egnell, G., Holmstrom, H., Marland, G and Ågren, G. (2017). Carbon balances of bioenergy systems using biomass from forests managed with long rotations: bridging the gap between stand and landscape assessments. *Global Change Biology Bioenergy*. Retrieved from doi: 10.1111/gcbb.12425, 2017

Galik, C.S. and Abt. R.C. (2012). The effect of assessment scale and metric selection on the greenhouse gas benefits of woody biomass. *Biomass and Bioenergy* 44:1–7.

Galik, Christopher S, and Robert C. Abt. (2012). "The Effect of Assessment Scale and Metric Selection on the Greenhouse Gas Benefits of Woody Biomass." *Biomass and Bioenergy* 44 (September): 1–7. doi:http://dx.doi.org/10.1016/j.biombioe.2012.04.009.

IPCC (Intergovernmental Panel on Climate Change). (2007). *Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007.* Cambridge, United Kingdom and New York, NY. Retrieved from [HYPERLINK "http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf"].

Jonker, Jan G.G., Junginger, M. and Faaij, A. (2014). "Carbon Payback Period and Carbon Offset Parity Point of Wood Pellet Production in the South-Eastern United States." *Global Change Biology Bioenergy* 6 (4): 371–89. doi:10.1111/gcbb.12056.

Lamb, B.K., Cambaliza, M.O.L., Davis K.J., Edburg, S.L., Ferrara, T.W., Floerchinger, C., Heimburger, A.M.F., Herndon, S., Lauvaux, T., Lavoie, T., Lyon, D.R., Miles, N., Prasad, K.R., Richardson, S., Roscioli, J.R., Salmon, O.E., Shepson, P.B., Stirm, B.H. and Whetstone, J. (2016) Direct and Indirect Measurements and Modeling of Methane Emissions in Indianapolis, Indiana *Environmental Science and Technology*. 50: 8910-8917

Mitchell, Stephen R., Harmon, M.E. and O'Connell, K.E.B. (2012). "Carbon Debt and Carbon Sequestration Parity in Forest Bioenergy Production." *GCB Bioenergy* 4 (6): 818–27. doi:10.1111/j.1757-1707.2012.01173.x.

ED_004741_00009059-00032

National Council for Air and Stream Improvement. (2015). Comment to the Biogenic Carbon Emissions Panel of the EPA Science Advisory Board. August 5, 2015. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/254A0104C4745E5785257E98006493E4/$File/NCASI+comments+for+Aug.+6,+2015.pdf"]

Ocko, I.B., Hamburg, S.P., Jacob, D.J., Keith, D.W., Keohane, N.O., Oppenheimer, M., Roy-Mayhew, J.D., Schrag, D. P. and Pacala, S.W. (2017) Two-valued Global Warming Potential Effectively Captures Long- and Short-term Climate Forcing. *Science.* 356:492-493

Shoemaker, J.K., Schrag, D.P., Molina, M.J. and Ramanathan, V. (2013). "What Role for short-Lived Climate Pollutants in Mitigation Policy?" *Science* 342: 1323-1324.

Ter-Mikaelian, Michael T., Colombo, S.J. and Chen, J. (2015). "The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions? A Review of Common Misconceptions about Forest Carbon Accounting. " *Journal of Forestry* 113 (1): 57–68.

U.S. EPA (Environmental Protection Agency). (2011). *Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources.* Office of Atmospheric Programs. Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886/$File/Biogenic_CO2_Accounting_Framework_Report_LATEST.pdf.

U.S. EPA (Environmental Protection Agency). (2014). *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources.* Retrieved from https://yosemite.epa.gov/sab/sabproduct.nsf//LookupWebProjectsCurrentBOARD/3235DAC747C16FE985257DA90053F252/$File/Framework-for-Assessing-Biogenic-CO2-Emissions+(Nov+2014).pdf.

U.S. EPA (Environmental Protection Agency). (2015). *Response to the SAB Panel Peer Review Advisory*. Retrieved from SAB Biogenic Carbon Emissions Panel Meeting Webpage. Retrieved from [HYPERLINK "http://yosemite.epa.gov/sab/SABPRODUCT.nsf/5295DAC6053510F285257DFD0075C181/$File/OAR+Response+to+SAB's+2012+Advice.pdf"].

U.S. EPA SAB (U.S. EPA Science Advisory Board). (2012). *SAB Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources*. Retrieved from SAB website : [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf"].

Walker, Thomas, Cardellichio, P., Colnes, A., Gunn, J., Kittler, B. Perschel, B., Recchia,C. and Saah, D. (2010). "Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources." Manomet Center for Conservation Sciences, no. June: 182. doi:NCI-2010-03.

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APPENDIX A: CHARGE TO THE SAB

February 25, 2015

MEMORANDUM

To: **Holly Stallworth, Designated Federal Official**
Science Advisory Board Staff Office

From: Paul Gunning, Director
Climate Change Division

Subject: **Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources and Charge Questions for SAB peer review**

The purpose of this memorandum is to transmit the revised *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources,* related documentation and charge questions for consideration by the Science Advisory Board (SAB) during your upcoming peer review.

In January 2011, the U.S. Environmental Protection Agency (EPA) announced a series of steps it would take to address biogenic CO_2 emissions from stationary sources. EPA committed to conduct a detailed examination of the science and technical issues related to assessing biogenic CO_2 emissions from stationary sources and to develop a framework for evaluating those emissions. The draft study was released in September 2011 and subsequently peer reviewed by the SAB Ad-Hoc Panel on Biogenic Carbon Emissions (SAB Panel). The final peer review report was published September 2012.

To continue advancing the agency's technical understanding of the role that biomass use can play in reducing overall greenhouse gas emissions, the EPA released a second draft of the technical report, *Framework for Assessing Biogenic Carbon Dioxide for Stationary Sources*, in November 2014. This revised report presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions. The revised report takes into account the SAB Panel's peer review recommendations on the draft 2011 Framework as well as the latest information and input from the scientific community and other stakeholders.

The revised framework addressed many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis, including an alternative fate approach for waste-derived feedstocks and certain industrial processing products and byproducts; an evaluation of tradeoffs from using different temporal scales; an improved representation of the framework equation; and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales.

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We ask the SAB to review and offer recommendations on specific technical elements of the revised framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions, as identified in the charge accompanying this memo. We look forward to the SAB's review.

Please contact me if you have any questions about the attached study and charge.

Attachments:

1) *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*
2) Technical Appendices
3) Response to the 2011 SAB Panel Peer Review Advisory

Peer Review Charge on the Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

To improve the quality, utility, and scientific integrity of the Framework, EPA is providing this study, *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (November 2014) and related materials to the Science Advisory Board (SAB). The revised report takes into account the SAB Biogenic Carbon Emissions Panel's ("SAB Panel") peer review recommendations[2] on the draft 2011 Framework[3] as well as the latest information and input from the scientific community and other stakeholders. The "Response to SAB" document included in the materials provided for this review discusses and responds to the SAB Panel key points and recommendations, serving as a guide to how the revised framework incorporates their recommendations. This charge narrowly focuses on a few specific remaining questions that were not explicitly addressed in the initial SAB Panel peer review report.

The revised 2014 framework report identifies key scientific and technical factors associated with assessing biogenic CO_2 emissions from stationary sources using biogenic feedstocks, taking into account information about the carbon cycle. It also presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions.

The revised framework and the technical appendices address many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis (Appendices J-L); an alternative fate approach for waste-derived feedstocks (Appendix N); and certain industrial processing products and byproducts (Appendix D Addendum); an evaluation of tradeoffs from using different temporal scales (Appendix B); an improved representation of the framework equation (Appendix F); and illustrative case studies demonstrating how the framework equation can be applied, using region-

[2] The final peer review report from the SAB Panel on the draft 2011 framework was published on September 28, 2012 (Swackhamer and Khanna, 2011). Information about the SAB peer review process for the September 2011 draft framework is available at [HYPERLINK "http://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886"].

[3] The 2011 *Draft Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources* is available at [HYPERLINK "http://www.epa.gov/climatechange/ghgemissions/biogenic-emissions.html"].

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feedstock combinations to generate regional defaults per different baseline approaches and temporal scales (Appendices H-N).

As explained in the revised framework introduction and accompanying SAB response document, the revised framework maintains the policy neutral approach from the 2011 draft Framework. It is a technical document that does not set regulatory policy nor does it provide a detailed discussion of specific policy and implementation options. Ultimately, the framework provides a methodological approach for considering, and a technical tool (the framework equation) for assessing, the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources. The revised framework details technical elements that should be considered as appropriate per specific policy applications or biogenic carbon-based feedstock assessments. Therefore, this charge excludes policy and regulatory recommendations or legal interpretation of the Clean Air Act's provisions related to stationary sources.

The revised report does not provide any final values or determinations: it offers indications of different biogenic feedstock production effects per research and analyses conducted, including illustrative example results per specific case study parameters. As discussed by the previous SAB Panel, this report also finds that biophysical and market differences between feedstocks may necessitate different technical approaches. Even using a future anticipated baseline approach, forest- and agriculture-derived feedstock characteristics, and thus analyses and results, may vary per region and per feedstock, and may be influenced by land use change effects. Illustrative analyses conducted for specific waste-derived feedstock case studies using a counterfactual anticipated baseline, as recommended by the SAB Panel, yielded minimal or negative net emissions effects.

This charge focuses on questions that remain regarding whether there are more definitive technical determinations appropriate for parameterizing key elements of the revised framework, regardless of application to a specific policy or program. Specifically, we ask that the SAB Panel examine and offer recommendations on future anticipated baseline specification issues in the context of assessing the extent to which the production, processing, and use of forest- and agriculture-derived biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions – such as appropriate temporal scales and the scale of biogenic feedstock usage (model perturbations or 'shocks') for analyzing future potential bioenergy production changes.

Technical approaches, merits and challenges with applying a future anticipated baseline

Establishing a baseline creates a point of comparison necessary for evaluating changes to a system.[4] Baseline specification can vary in terms of what entity or groups of entities are being analyzed (e.g., industries, economic sectors), temporal and spatial scales, geographic resolution, and, depending on context, environmental issues/attributes (EPA, 2010).[5] The choice of baseline approach can also depend

[4] Definitions for baseline vary, including "the reference for measurable quantities from which an alternative outcome can be measured" (IPCC AR4 WGIII, 2007) or "the baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines" (IPCC AR4 WGII, 2007).

[5] Guidelines for Preparing Economics Analyses (NCEE), Chapter 5: [HYPERLINK "http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-05.pdf/$file/EE-0568-05.pdf"]

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on the question being asked and the goal of the analysis at hand. For example, some GHG analysis may require a baseline against which historic changes of landscape carbon stocks can be measured. Other applications may necessitate a baseline against which the estimated GHG emissions and sequestration associated with potential future changes in related commodity markets and policy arenas. Analyses of the estimated GHG emissions and sequestration effects from changes in biomass use have used different baseline approaches, as well as a wide range of different temporal scales and alternative scenario parameters (Sohngen and Sedjo, 2000; Fargione, 2008; UNFCCC, 2009; Walker et al., 2010; Cherubini et al, 2011; Galik and Abt, 2012; Latta et al., 2013; Walker et al., 2013; AEO, 2014; U.S. EPA, 2014; Miner et al., 2014).

The draft 2011 framework had discussed three different potential baseline approaches – reference point, future anticipated and comparative – and used the reference point baseline in its hypothetical case study applications of the Framework. The SAB Panel in its review stated that "the choice of a fixed reference point may be the simplest to execute, but it does not actually address the question of the extent to which forest stocks would have been growing/declining over time in the absence of a particular bioenergy facility" (SAB Advisory, p. 29). The SAB Panel expressed concern that the reference point baseline does not address the important question of additionality, or what would have been the trajectory of biogenic CO_2 stocks and fluxes in the absence of an activity or activities using biogenic feedstocks for energy, especially in the context of forest-derived feedstocks.[6] "Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach" (SAB Letter, p. 2).

Through public comments to the SAB Panel during the 2011-2012 SAB peer review process, various stakeholders expressed divergent perspectives on the appropriate baseline for the draft 2011 framework report.[7] The revised 2014 framework retains the reference point baseline and adds the anticipated baseline in order to retain adaptability for potential applications, and discusses both approaches at length in the revised report and several technical appendices. However, as the SAB Panel was clear in its previous review of the reference point baseline, EPA has no outstanding technical questions for the SAB Panel on that baseline approach. This charge focuses specifically on remaining technical questions that EPA has on the future anticipated baseline approach.

Part 1 – Future anticipated baseline approach and temporal scale

[6] The difference in net atmospheric CO_2 emissions contributions with and without changes in biogenic feedstock use is known as additionality (Murray et al., 2007). Additionality can be determined by assessing the difference in potential net atmospheric CO_2 emissions of a specific level of biogenic feedstock use over a certain period of time (in many cases the business-as-usual [BAU] baseline) versus the net atmospheric CO_2 emissions contributions that would have occurred over the same time period with a different level of biogenic feedstock use (counterfactual scenario), holding other factors and assumptions consistent between scenarios.

[7] The American Forest and Paper Association (AF&PA) supported the reference point baseline (e.g., comments submitted October 2011, March 2012) applied historically (January 2012, March 2012). The National Alliance of Forest Owners (NAFO) stated if certain feedstocks weren't categorically excluded, then the historical reference point baseline should be used (e.g., March 2012, August 2012). The U.S. Department of Agriculture stated preference for a historic baseline approach (May 2012). The Environmental Defense Fund (EDF) (January 2012, May 2012) and NCASI (October 2011, March 2012) both supported the retrospective reference point approach, though also both offered recommendations if an anticipated baseline approach was included (EDF for future anticipated and NCASI for counterfactual). Others, such as Green Power Institute (March 2012), the National Resource Defense Council (NRDC, August 2012), Becker et al. (August 2012), Biomass Energy Resource Center et al. (February 2012), and a group scientists letter to EPA (June 2014) all support some form of the anticipated baseline approach (future anticipated and/or counterfactual).

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It is important to consider possible treatments of time and the implications of these treatments in developing strategies for long-term and short-term emissions assessment, because the choice of treatment may have significant impacts on the resultof an assessment framework application. For the intended use of the revised Framework – assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions – there are different elements of time to consider when using a future anticipated baseline approach. These elements can include:

- Emissions horizons, assessment or policy horizons, and reporting periods (i.e., fluxes related to feedstock production may occur over many years to decades, whereas reporting may be the current year and policies may cover only a few years or decades), and
- Differences in temporal characteristics of different feedstocks (i.e., annual crops, short rotation energy crops, and longer rotation forestry systems).
- Changes in biophysical and economic conditions over time may affect or differ from those in future anticipated baseline and scenario estimates.

The SAB Panel in its previous peer review noted that "this is a complicated subject because there are many different time scales that are important for the issues associated with biogenic carbon emissions" (Advisory, page 13). They discussed multiple temporal scales associated with mixing of carbon throughout the different reservoirs on the Earth's surface at the global scale (Advisory, page 13) and climate responses to CO_2 and other greenhouse gases (Advisory, page 15), implications of temporal scales greater and shorter than 100 years, and those related to the growth cycles of different feedstock types (Advisory, page 15). The SAB Panel specifically highlighted considerations for using a 100-year or longer temporal scale for evaluating climate impacts and radiative forcing[8] as well as decay rates and carbon storage in forest ecosystems in the main text as well as in Appendices B-D. However, in its recommendations, including those for developing default BAFs per region, the SAB Panel did not offer recommendations per what temporal scale to use in the specific context of the Framework for its intended use and scope. Instead, the SAB Panel stated that "there is no scientifically correct answer when choosing a time horizon, although the *Framework* should be clear about what time horizon it uses, and what that choice means in terms of valuing long term versus shorter term climate impacts (Advisory, page 15) and recommended that a revised framework "incorporate various time scales and consider the tradeoffs in choosing between different time scales" (Advisory, page 43).

Multiple stakeholders have also weighed in on temporal scales, some with specific recommendations on what temporal scale should/could be used for framework assessments, others with no specific recommendations but emphasizing the importance of time. In various comments submitted during the 2011-2012 SAB process, NAFO supported a 100-year timeframe (March 2012). The National Council for Air and Stream Improvement (NCASI) in October 2011 comments suggested "the need for

[8] EPA acknowledges that the long-term climate impacts of shifting from fossil fuel to biogenic energy sources is an important topic for climate change mitigation policy and also recognizes the extensive work being conducted by EPA and throughout the research community on this question. However, EPA's focus here is on a narrower, more targeted goal of developing tools to assess the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic feedstocks at stationary sources. This more narrowly defined assessment is anticipated to be a better fit for the types of program and policy applications in which this framework may potentially be applied.

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considerable flexibility in setting the temporal scales for determining the stability of forest carbon stocks. There are a range of circumstances that can cause transient trends in carbon stocks that can obscure the more relevant long-term picture."

Other groups, such as The Wilderness Society (TWS), NRDC, EDF and others, submitted comments supporting consideration of shorter temporal scales. In its comments and example calculations, TWS (in October 2011 comments) implied support for shorter temporal scales, and stated in later comments that the SAB "text appears biased toward ignoring effects that occur within a 100-year period" (May 2012). NRDC (August 2014) implied support for shorter temporal scales: "even if near-term carbon emissions increases are eventually 'made up' by regrowth over the very long term, the carbon emission from these types of biomass actually exceed those from fossil fuels for decades. This puts use of these types of biomass fuels in conflict with the urgent need for near-term carbon emissions reductions. The time profile of the carbon emission from biogenic fuel sources matters because it is critical to limit near-term global GHG emissions." This perspective was similar to that shared by Becker et al. in their August 2012 comments. EDF (January 2012) suggested a very short temporal scale (in the context of supporting a retrospective reference baseline). Others, such as the Biotechnology Industry Organization (October 2011) simply asked for "clarification on the methodology used to identify the time scale of carbon cycles."

Per the various recommendations above, the revised framework report and the technical appendices include a more detailed discussion of intertemporal tradeoffs inherent in various options for treating emissions over time in the context of assessing biogenic CO_2 emissions from stationary sources. Specifically, the revised report has: a section on key temporal scale considerations (pages 33-38); an appendix dedicated to temporal scale issues (Appendix B), which includes further discussion of temporal scales in the context of future anticipated baselines and decay rates for feedstocks that would have otherwise decayed if not used for energy, and; an appendix describing the background of and modeling considerations for constructing an anticipated baseline approach (Appendix J). Also, illustrative calculations using the future anticipated baseline estimates use future simulations and thereby explicitly incorporate temporal patterns of different feedstocks (e.g., feedstock growth rates, decay rates) into the analysis and shows how results can vary per temporal scale used (as seen in Appendices K and L). The revised framework does not recommend specific temporal scales for framework applications, but rather identifies different elements of and considerations concerning time to provide insights into the potential implications of using different temporal scales.

EPA seeks guidance on the following issues regarding appropriate temporal scales for assessing biogenic CO_2 emissions using a future anticipated baseline, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the previous SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of temporal scale both within and outside of a specific policy context.

Part 1 – Future anticipated baseline approach and temporal scale

1. What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of

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biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

a. Should the temporal scale for computing BAFs vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.
    i. If temporal scales for computing BAFs vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?
    ii. Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?
    iii. Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default BAFs versus crafting policy specific BAFs?
b. Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?
c. Should calculation of the BAF include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?
d. What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions *ex post*), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

Part 2 – Scales of biomass use when applying future anticipated baseline approach

EPA seeks guidance on technical considerations concerning how to select model perturbations ('shocks') for future anticipated baseline simulations estimating the net atmospheric contribution of biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework

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could be also be used in specific policy contexts, the questions below relate to the choice of model shocks both within and outside of a specific policy context.

2. What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?
   a. Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
   b. What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?
   c. Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?
   d. Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?
   e. For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).
   f. How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?
   g. Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?
   h. What considerations could be useful when evaluating the performance of the demand shock choice *ex post*, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward

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APPENDIX B: MEMBERS OF THE BIOGENIC CARBON EMISSIONS PANEL

CHAIR

Dr. Madhu Khanna, ACES Distinguished Professor in Environmental Economics, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Urbana, IL

PANEL MEMBERS

Dr. Robert Abt, Professor of Forestry, Department of Forestry and Environmental Resources, College of Natural Resources, North Carolina State University, Raleigh, NC

Dr. Morton Barlaz, Professor, Civil, Construction, and Environmental Engineering, Engineering, North Carolina State University, Raleigh, NC

Dr. Marilyn Buford, National Program Leader, Silviculture Research, Research & Development, USDA Forest Service, Washington, DC

Dr. Mark Harmon, Professor and Richardson Chair, College of Forestry, Oregon State University, Corvallis, OR

Dr. Jason Hill, Associate Professor, Bioproducts and Biosystems Engineering, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota, St. Paul, MN

Dr. John Reilly, Senior Lecturer and Co-Director, Joint Program on the Science and Policy of Global Change, Center for Environmental Policy Research, E19-439L, Massachusetts Institute of Technology, Cambridge, MA

Dr. Charles Rice, Distinguished Professor, Department of Agronomy, Soil Microbiology, Kansas State University, Manhattan, KS

Dr. Steven Rose, Senior Research Economist, Energy and Environmental Analysis Research Group, Electric Power Research Institute, Palo Alto, CA

Dr. Daniel Schrag, Professor of Earth and Planetary Sciences, Harvard University, Cambridge, MA

Dr. Roger Sedjo, Senior Fellow and Director of the Center for Forest Economics and Policy Program, Resources for the Future, Washington, DC

Dr. Ken Skog, Supervisory Research Forester (retired), Economics and Statistics Research, Forest Products Laboratory, USDA Forest Service, Madison, WI

Dr. Tristram West, Ecosystem Scientist, Joint Global Change Research Institute, University of Maryland, College Park, MD

Dr. Peter Woodbury, Senior Research Associate, Department of Crop and Soil Sciences, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, U.S.A.

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SCIENCE ADVISORY BOARD STAFF

Dr. Holly Stallworth, Designated Federal Officer, U.S. Environmental Protection Agency, Washington, DC

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Science Advisory Board Work Group's DRAFT Fact-finding Questions on EPA Planned Actions in the Spring 2018 Regulatory Agenda

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2060-AT85 Miscellaneous Organic Chemical Manufacturing and Miscellaneous Coating Manufacturing Residual Risk and Technology Reviews
No questions

2060-AT86 National Emission Standards for Hazardous Air Pollutants: Organic Liquids Distribution (Non-Gasoline) RTR
No Questions

2060-AT89 Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NSR): Project Emissions Accounting
No Questions

2060-AT90 Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Review

The Work Group notes that a similar action was identified Spring 2017 Unified Agenda of Regulatory and Deregulatory Action. In a letter dated June 21, 2018 the chartered SAB found:

> *Review of the 2016 Oil and Gas New Source Performance Standards for New, Reconstructed, and Modified Sources (RIN 2060-AT54)* merits review by the SAB. The SAB noted RIN 2060-AT54 was similar to actions SAB previously has considered including two previous actions regarding Oil and Gas New Source Performance Standards: 1) *Oil and Natural Gas Sector: Reconsideration of Remaining Provisions of New Source Performance Standards (RIN 2060-AS30);* and 2) *Guidelines for the Existing Oil and Natural Gas Sector (RIN 2060–AT29).* The SAB found that the EPA sought out expert review and public input and determined that the *Remaining Provisions to the NSPS (RIN 2060-AS30)* did not merit further review[1] stating that further SAB input was likely to provide marginal benefits to the Agency's expert input processes. The SAB deferred consideration of a related rule, the *Emission Guidelines for the Existing Oil and Natural Gas Sector (RIN 2060–AT29)* noting there was insufficient information to review the

[1] Preparations for Chartered SAB Discussions of EPA Planned Actions and Their Supporting Science in the Fall 2014 Regulatory Agenda (Attachment B and C) available at: [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/8D67738EFAF3C69385257E3500532AF6/$File/Work+Group+Memorandum+Fall+2014+Reg+Rev+posted.pdf"]

planned action and the SAB requested the agency provide more information about the scientific and technical basis. The Agency informed the SAB that the Guideline rule (2060-AT29) withdraws the 2016 Information Collection Request (ICR) from the oil and gas industry and no further activity is anticipated. Thus, this action is currently listed as completed in the Spring 2017 Regulatory agenda.

1. Can the agency provide any additional information on the scientific and technical work products that will support the adequacy of 2060-AT90?

2. Does the agency anticipate that planned action 2060-AT90 will address all the scientific and technical issues identified in the public comments received for 2060-AT54 or are additional actions planned?

3. Can the agency provide any information regarding~~in~~ the differences in ~~the~~ scientific and technical information that was~~ere~~ used in the development of promulgated actions 2060-AS30 and 2060-AT29, that were previously reviewed by the SAB and identified in the June 21, 2018, letter to Administrator Pruitt and the current planned action, 2060-AT90?

2060-AT93Renewable Fuel Volume Standards for 2019 and Biomass Based Diesel Volume (BBD) for 2020

No Questions

2060-AT99 Mercury and Air Toxics Standards for Power Plants Residual Risk and Technology Review and Cost Review

~~1. Please provide to the SAB the full proposed rule and accompanying documents as soon as they are published (I presume this is already planned, but I am including the question as an obvious placeholder).~~

1. Are there additional documents that the SAB should ~~see~~ review relevant to scientific ~~a~~ and technical adequacy of the planned action in addition to those listed on the last page of EPA's description of the planned action?
2. Are there new, unique or specific data underlying the MATS rule that ha~~ve~~s not been peer reviewed and can the agency provide any additional information on plans to ~~the~~ review those data? Please give more details about how EPA proposes to peer review and incorporate these data conductin theits Risk and Technology Review. ~~In particular, what specific questions will the RTR be asked to address, and what scientific methodologies (whether they are new or well-established) will they involve?~~
3. The document states that the MATS Supplemental Cost Finding "will not involve scientific work products". What is the scientific basis by which the findings on cost and co-benefits are being developed? ~~How is it possible to produce a credible finding on costs without any scientific input? Isn't there a role for the SAB here?~~
4. ~~On the question of peer review (Section 6(d)), the document cites several peer reviews of past EPA actions but apparently does not see any need for peer review of the present actions. Given the high level of public interest that is certain to follow the publication of~~

Commented [CT1]: SAB will have access if the agency waits until proposal is published Do we need a placeholder. Suggest dropping the question.

Commented [CT2]: The SAB just reviewed the [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/2708C2DBC83930168525806000 5C87E8?OpenDocument"]reviews and provided a [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/8E5A4936D37FED058525829D0057499C/$File/Technology+Review+SAB+Presentation+May+31+2018+FINAL.pdf"] on the technology review at the May 2018 meeting

~~the proposed rule, would it not be better to conduct a full peer review, in order to ensure the credibility of whatever recommendation eventually emerges?~~

~~5. How does EPA intend to plan for different possible court rulings on the co-benefits issue?~~

Commented [AC3]: Is there a fourth question after editing? I believe we folded everything into the first three now.

2060-AU09 Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy

~~After reviewing the various documents for "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Duty Trucks", I've put together the following 3 questions that I feel could help clarify some of the key points of the Mid-Term Evaluation.~~

1. ~~-~~In regard to fleet electrification, what are the key ~~assumption~~ differences in assumptions underlying ~~in the~~ the fleet EV/PHEV penetration for 2026 using the Argonne National Laboratory Automonie model compared to the assumptions underlying ~~sed in~~ the 2012 rule?
2. New vehicle cost is a key component of fleet dynamics. Is EPA taking into consideration any long-term effects of price increases due to trade/tariff economics on the vehicle prices and subsequent cost of new technology implementation?
3. What approaches or model~~s~~ will EPA, NHTSA and California use to harmonize to a national program, and how will the assumptions underlying~~to~~ those approaches or~~al~~ models be reviewed?

~~Since this is my first attempt at preparing questions, these may be totally out of the scope of the SAB. However, most of the other items seemed to be under DOE, NHTSA, OMB or some other government agency. I hope I'm at least close on a couple of them.~~

2080-AA14 Strengthening Transparency in Regulatory Science

The Work Group notes that Chartered SAB sent a letter to Administrator Pruitt on June 28, 2018 regarding the SAB's wishes to provide advice and comment on the scientific and technical adequacy of the proposed rule and is awaiting an agency response.

2040-AF81 Peak Flow Management[2]

1. How will the "consistent national approach" that "provides for efficient treatment plant operations" deal with the variety of engineering processes employed at POTWs across the nation?
2. Since wet weather flows are usually dilute, it is often difficult, if not impossible, to achieve the 85% removal of BOD5 and TSS required by the current regulations during these periods. What scientific information~~, duration, and frequency~~ will EPA use to establish minimum alternative removal requirements (e.g. on duration and frequency)?
3. How will the "potential health effects of inadequately treated sewage" be quantified and compared to alternative treatment and/or operational scenarios?

[2] The EPA changed the name of this action from Updates to Wet Weather Treatment Regulations for POTWs to Peak Flows Management.

4. Will capital, operational, and maintenance costs be considered in establishing alternative removal requirements and estimating risks?

5. As mentioned in the EPA description, POTW's use various operational practices to protect the secondary treatment units during wet weather events however, these are often limited by equipment and process constraints. How does EPA plan to balance costs and risks to account for these "real world" situations?

6. Collection system conditions limit conveyance capacity that can result in longer term flow hydrographs that further exacerbate wet weather operational options. Will EPA establish a default return storm event, and if so, on what basis?

6.

Commented [BB4]: Yes it was

Commented [CT5]: Is this one missing a question?

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~~RIN~~ 2040-AF83 Clean Water Act Section 404 Assumption Update Regulations

1. SAB recognizes that this regulation is likely to be largely procedural and administrative in nature as the 404/401 program is well established. The EPA brief description indicates that the "rule would clarify and discern" the extent of waters assumed by states/tribes. Will the regulation be promulgated in conjunction with the USACE, and if so, or if not, what are the ~~common~~ scientific principles that are being appli~~considere~~d for identification of assumable/retained waters?

2. Will the regulation incorporate a scientific basis for establishing an administrative boundary ~~to facilitate USACE discussions and provide clarity to the public~~? If so, what alternatives are being considered to establish such a boundary?

~~2.~~3. How do the revisions to WOTUS effect the timing and underlying science related to assumable waters?

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Commented [BB6]: Question added to address Tom Parkerton's 2nd question.

2060-AU03 Treatment of Biogenic CO2 Emissions Under the Clean Air Act Permitting Programs

1. Does the proposed action utilize a new scientific basis, separate from ~~the~~ ~~In light of~~ the existing Framework for Assessing Biogenic CO2 Emissions from Stationary Sources (2014)~~, does the proposed action utilize any new scientific basis for ignoring the existing framework and~~ underlying the ~~findings~~ declaration of~~ing~~ managed forest derived biomass as carbon neutral?
2. How was the proposed policy developed? Is it strictly an arbitrarily derived policy statement, or is it based on some logical framework not previously provided for SAB review?

Commented [CT7]: We are assuming policy refers to the 4/23/18 [HYPERLINK "https://www.epa.gov/sites/production/files/2018-04/documents/biomass_policy_statement_2018_04_23.pdf"]. The policy states the agency is acting under the provisions in the Consolidated Appropriations Act, 2018 and "[t]This statement of agency policy is not a scientific determination and does not revise or amend any scientific determinations that EPA has previously made." Suggest dropping or revising the question

Commented [AC8]: I would drop this one. If kept we need to reword carefully to be sure we are focusing on scientific determinations.

2060-AU10 General National Ambient Air Quality Standards Implementation Update Rule

The Work Group notes that the Agency has not determined a time table or identified scientific work products to inform decisions regarding the planned action.

1. Has the agency received advice from any of the other high level external review bodies (i.e. National Academy of Sciences, the Clean Air Act Advisory Committee or the Clean Air Scientific Advisory Committee) on the planned action?-
2. Is the agency considering engaging any of these external review bodies to review work products to support the scientific and technical adequacy of the planned action.

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No Questions

2060-AT90 Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Review

The Work Group notes that a similar action was identified Spring 2017 Unified Agenda of Regulatory and Deregulatory Action. In a letter dated June 21, 2018 the chartered SAB found:

> *Review of the 2016 Oil and Gas New Source Performance Standards for New, Reconstructed, and Modified Sources (RIN 2060-AT54)* merits review by the SAB. The SAB noted RIN 2060-AT54 was similar to actions SAB previously has considered including two previous actions regarding Oil and Gas New Source Performance Standards: 1) *Oil and Natural Gas Sector: Reconsideration of Remaining Provisions of New Source Performance Standards (RIN 2060-AS30);* and 2) *Guidelines for the Existing Oil and Natural Gas Sector (RIN 2060–AT29).* The SAB found that the EPA sought out expert review and public input and determined that the *Remaining Provisions to the NSPS (RIN 2060-AS30)* did not merit further review[1] stating that further SAB input was likely to provide marginal benefits to the Agency's expert input processes. The SAB deferred consideration of a related rule, the *Emission Guidelines for the Existing Oil and Natural Gas Sector (RIN 2060–AT29)* noting there was insufficient information to review the

[1] Preparations for Chartered SAB Discussions of EPA Planned Actions and Their Supporting Science in the Fall 2014 Regulatory Agenda (Attachment B and C) available at: [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/8D67738EFAF3C69385257E3500532AF6/$File/Work+Group+Memorandum+Fall+2014+Reg+Rev+posted.pdf"]

planned action and the SAB requested the agency provide more information about the scientific and technical basis. The Agency informed the SAB that the Guideline rule (2060-AT29) withdraws the 2016 Information Collection Request (ICR) from the oil and gas industry and no further activity is anticipated. Thus, this action is currently listed as completed in the Spring 2017 Regulatory agenda.

1. Can the agency provide any additional information on the scientific and technical work products that will support the adequacy of 2060-AT90?

2. Does the agency anticipate that planned action 2060-AT90 will address all the scientific and technical issues identified in the public comments received for 2060-AT54 or are additional actions planned?

3. Can the agency provide any information regarding~~in~~ the differences in ~~the~~ scientific and technical information that was~~ere~~ used in the development of promulgated actions 2060-AS30 and 2060-AT29, that were previously reviewed by the SAB and identified in the June 21, 2018, letter to Administrator Pruitt and the current planned action, 2060-AT90?

2060-AT93Renewable Fuel Volume Standards for 2019 and Biomass Based Diesel Volume (BBD) for 2020

No Questions

2060-AT99 Mercury and Air Toxics Standards for Power Plants Residual Risk and Technology Review and Cost Review

1. ~~Please provide to the SAB the full proposed rule and accompanying documents as soon as they are published (I presume this is already planned, but I am including the question as an obvious placeholder).~~
1. Are there additional documents that the SAB should ~~see~~ review relevant to scientific ~~a~~ and technical adequacy of the planned action in addition to those listed on the last page of EPA's description of the planned action?
2. Are there new, unique or specific data underlying the MATS rule that haves not been peer reviewed and can the agency provide any additional information on plans to ~~the~~ review those data? Please give more details about how EPA proposes to peer review and incorporate these data ~~conduct~~in the~~its~~ Risk and Technology Review. ~~In particular, what specific questions will the RTR be asked to address, and what scientific methodologies (whether they are new or well-established) will they involve?~~
3. The document states that the MATS Supplemental Cost Finding "will not involve scientific work products". What is the scientific basis by which the findings on cost and co-benefits are being developed? ~~How is it possible to produce a credible finding on costs without any scientific input? Isn't there a role for the SAB here?~~
4. ~~On the question of peer review (Section 6(d)), the document cites several peer reviews of past EPA actions but apparently does not see any need for peer review of the present actions. Given the high level of public interest that is certain to follow the publication of~~

Commented [CT1]: SAB will have access if the agency waits until proposal is published Do we need a placeholder. Suggest dropping the question.

Commented [CT2]: The SAB just reviewed the [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/2708C2DBC83930168525806000 5C87E8?OpenDocument"]reviews and provided a [HYPERLINK "https://yosemite.epa.gov/sab/sabproduct.nsf/8E5A4936D37FED058525829D0057499C/$File/Technology+Review+SAB+Presentation+May+31+2018+FINAL.pdf"] on the technology review at the May 2018 meeting

~~the proposed rule, would it not be better to conduct a full peer review, in order to ensure the credibility of whatever recommendation eventually emerges?~~

~~5. How does EPA intend to plan for different possible court rulings on the co-benefits issue?~~

Commented [AC3]: Is there a fourth question after editing? I believe we folded everything into the first three now.

2060-AU09 Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy

~~After reviewing the various documents for "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Duty Trucks", I've put together the following 3 questions that I feel could help clarify some of the key points of the Mid-Term Evaluation.~~

1. In regard to fleet electrification, what are the key ~~assumption~~ differences in assumptions underlying ~~in the~~ the fleet EV/PHEV penetration for 2026 using the Argonne National Laboratory Automonie model compared to the assumptions underlying ~~sed in~~ the 2012 rule?
2. New vehicle cost is a key component of fleet dynamics. Is EPA taking into consideration any long-term effects of price increases due to trade/tariff economics on the vehicle prices and subsequent cost of new technology implementation?
3. What approaches or model~~s~~ will EPA, NHTSA and California use to harmonize to a national program, and how will the assumptions underlying~~to~~ those approaches or~~at~~ models be reviewed?

~~Since this is my first attempt at preparing questions, these may be totally out of the scope of the SAB. However, most of the other items seemed to be under DOE, NHTSA, OMB or some other government agency. I hope I'm at least close on a couple of them.~~

2080-AA14 Strengthening Transparency in Regulatory Science

The Work Group notes that Chartered SAB sent a letter to Administrator Pruitt on June 28, 2018 regarding the SAB's wishes to provide advice and comment on the scientific and technical adequacy of the proposed rule and is awaiting an agency response.

2040-AF81 Peak Flow Management[2]

1. How will the "consistent national approach" that "provides for efficient treatment plant operations" deal with the variety of engineering processes employed at POTWs across the nation?
2. Since wet weather flows are usually dilute, it is often difficult, if not impossible, to achieve the 85% removal of BOD5 and TSS required by the current regulations during these periods. What scientific information~~, duration, and frequency~~ will EPA use to establish minimum alternative removal requirements (e.g. on duration and frequency)?
3. How will the "potential health effects of inadequately treated sewage" be quantified and compared to alternative treatment and/or operational scenarios?

[2] The EPA changed the name of this action from Updates to Wet Weather Treatment Regulations for POTWs to Peak Flows Management.

4. Will capital, operational, and maintenance costs be considered in establishing alternative removal requirements and estimating risks?

5. As mentioned in the EPA description, POTW's use various operational practices to protect the secondary treatment units during wet weather events however; these are often limited by equipment and process constraints.

Commented [CT4]: Is this one missing a question?

6. Collection system conditions limit conveyance capacity that can result in longer term flow hydrographs that further exacerbate wet weather operational options. Will EPA establish a default return storm event, and if so, on what basis?

~~RIN~~ 2040-AF83 Clean Water Act Section 404 Assumption Update Regulations

1. SAB recognizes that this regulation is likely to be largely procedural and administrative in nature as the 404/401 program is well established. The EPA brief description indicates that the "rule would clarify and discern" the extent of waters assumed by states/tribes. Will the regulation be promulgated in conjunction with the USACE, and if so, or if not, what are the ~~common~~ scientific principles that are being appli~~considere~~d for identification of assumable/retained waters?

2. Will the regulation incorporate a scientific basis for establishing an administrative boundary ~~to facilitate USACE discussions and provide clarity to the public~~? If so, what alternatives are being considered to establish such a boundary?

2060-AU03 Treatment of Biogenic CO2 Emissions Under the Clean Air Act Permitting Programs

1. Does the proposed action utilize a new scientific basis, separate from ~~the~~ ~~in light of~~ the existing Framework for Assessing Biogenic CO2 Emissions from Stationary Sources (2014)~~, does the proposed action utilize any new scientific basis for ignoring the existing framework and~~ underlying the ~~findings~~ declaration of~~ing~~ managed forest derived biomass as carbon neutral?
2. How was the proposed policy developed? Is it strictly an arbitrarily derived policy statement, or is it based on some logical framework not previously provided for SAB review?

Commented [CT5]: We are assuming policy refers to the 4/23/18 [HYPERLINK "https://www.epa.gov/sites/production/files/2018-04/documents/biomass_policy_statement_2018_04_23.pdf"]. The policy states the agency is acting under the provisions in the Consolidated Appropriations Act, 2018 and "[t]This statement of agency policy is not a scientific determination and does not revise or amend any scientific determinations that EPA has previously made." Suggest dropping or revising the question

Commented [AC6]: I would drop this one. If kept we need to reword carefully to be sure we are focusing on scientific determinations.

2060-AU10 General National Ambient Air Quality Standards Implementation Update Rule

The Work Group notes that the Agency has not determined a time table or identified scientific work products to inform decisions regarding the planned action.

1. Has the agency received advice from any of the other high level external review bodies (i.e. National Academy of Sciences, the Clean Air Act Advisory Committee or the Clean Air Scientific Advisory Committee) on the planned action?~~.~~
2. Is the agency considering engaging any of these external review bodies to review work products to support the scientific and technical adequacy of the planned action.

September 19, 2018

Science Advisory Board
US Environmental Protection Agency
Washington, DC

RE: Comments from the US Industrial Pellet Association on SAB Draft Report on EPA's 2014 Draft "Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources"

The US Industrial Pellet Association (USIPA) appreciates the opportunity to submit comments to the EPA Science Advisory Board (SAB) relating to the latest draft SAB report on biogenic carbon emissions. We appreciate the work that has been done by EPA and the SAB over the last several years and are hopeful that a conclusion can be reached on this issue in order to provide regulatory certainty around biogenic carbon accounting.

USIPA represents industrial-grade wood pellet manufacturers based in the US Southeast who are actively exporting their product for large-scale power production in Europe and Asia. Our members are using lower-grade wood fiber to create a low-cost, low-carbon alternative to fossil fuels. Using biomass for power production lowers carbon emissions by up to 90% when compared to coal. Wood pellets can be co-fired alongside fossil fuels, or can serve as stabilizing back-up power alongside other renewables like solar and wind.

Regulatory certainty is critical for the success of any industry, and bioenergy is no different. In order for renewables to compete on a global scale, government regulatory frameworks must be based on leading science and must be practical to implement. We have advocated to the SAB during this process that an anticipated future baseline or counterfactual modeling approach is unworkable because it is highly complex, makes arbitrary assumptions about future condition of forests, and suggests counterfactual scenarios that are subjective and impossible to predict. We are pleased to see that the most recent report from SAB (August 29, 2018) rightly expresses these same concerns over the complexity of using this approach for policy purposes.

We are also in agreement with the conclusions in the August 29 report which indicate that an accounting system which relies on measuring changes in carbon stocks at the landscape or regional level is more appropriate and practical. This type of approach is taken in the EU and is supported by carbon science, and is both practically applicable as well as environmentally sound. Thanks to this policy, the EU has a strong market for sustainably-sourced bioenergy, which displaces the use of fossil fuels, while also keeping energy systems balanced and costs stable.

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Thank you for your consideration of these comments. We hope that your work here will provide the regulatory certainty necessary to make the US a leader in smart energy policies that encourage the use of low-carbon fuels such as biomass.

Sincerely,

Seth Ginther
Executive Director
US Industrial Pellet Association (USIPA)

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American Forest & Paper Association

AMERICAN WOOD COUNCIL

September 18, 2018

Science Advisory Board
Environmental Protection Agency
Mail code 1400R
1200 Pennsylvania Ave., NW
Washington, DC 20460-4164

RE: AF&PA/AWC Comments on SAB's Draft Report on EPA's 2014 Draft "Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources."

Dear Members of the EPA Science Advisory Board (SAB):

The American Forest & Paper Association and the American Wood Council appreciate the opportunity to submit the following brief comments regarding the latest draft SAB report on the U.S. Environmental Protection Agency's (EPA) 2014 draft "Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources."

The American Forest & Paper Association (AF&PA) serves to advance a sustainable U.S. pulp, paper, packaging, tissue and wood products manufacturing industry through fact-based public policy and marketplace advocacy. AF&PA member companies make products essential for everyday life from renewable and recyclable resources and are committed to continuous improvement through the industry's sustainability initiative - *Better Practices, Better Planet 2020*. The forest products industry accounts for approximately four percent of the total U.S. manufacturing GDP, manufactures over $200 billion in products annually and employs more than 950,000 men and women. The industry meets a payroll of approximately $50 billion annually and is among the top 10 manufacturing sector employers in 45 states.

The American Wood Council (AWC) is the voice of North American wood products manufacturing, an industry that provides almost 450,000 men and women in the United States with family-wage jobs. AWC represents 86 percent of the structural wood products industry, and members make products that are essential to everyday life from a renewable resource that absorbs and sequesters carbon. Staff experts develop state-

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of-the-art engineering data, technology, and standards for wood products to assure their safe and efficient design, as well as provide information on wood design, green building, and environmental regulations. AWC also advocates for balanced government policies that affect wood products.

Forest products manufacturers are heavily regulated but must operate very efficiently in a fiercely competitive global market. The paper industry is particularly capital-intensive, and the industry has a long investment planning horizon. Accordingly, regulatory certainty is essential.

Baseline

We appreciate that the SAB's August 29, 2018 draft report recognizes the challenges of using an anticipated baseline approach for regulatory purposes. As the draft report puts it:

> ". . . The complexity of such an approach makes it difficult to parameterize and validate. The lack of empirical data regarding many of these relationships and the resulting uncertainties pose a significant challenge to use this type of model in the regulatory context. . . . Employing models of this complexity is likely beyond the capabilities of many practitioners."
>
> * * *
>
> "As stated in 2012, there are tradeoffs between ease of implementation (transaction costs), precision (getting it right in every location versus overall accuracy), and policy effectiveness (ensuring that the policy objectives are being met). We continue to recognize the difficulty of undertaking an anticipated baseline approach, and practicality should be an important consideration in the agency's decision making. All methods considered should be subject to an evaluation of the costs of implementation and compliance and weighed against any increase in accuracy and precision that they might yield. Ultimately, it is critical that there is a balance between accuracy and minimization of implementation costs." (p. 7)

We strongly agree with these concerns and continue to believe that a reference point baseline approach is better suited for regulatory purposes. Anticipated baselines are extremely complex to model and can lack practicability, accuracy and predictability compared with a simpler, more straightforward reference point baseline approach in the regulatory context. This is confirmed by the 2014 study by Buchholz et al., entitled,

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"Uncertainty in Projecting GHG Emissions from Bioenergy,"[1] which is referenced in the SAB's draft report (p. 19).

Key insights provided by the Buchholz et al. study include the following:

- Considering the particular context for which it is to be used, at some point the level of uncertainty rules out the usefulness of a baseline.
- "[A]n anticipated future baseline has one major caveat: being a forward-looking tool relying on additional assumptions beyond measurable data points (as applied with a constant reference point baseline), the uncertainty associated with an anticipated future baseline increases over time."
- ***"[N]ever in 30 years of timber trend assessments have the near-term anticipated future projections of surplus roundwood been as accurate as the constant reference would have been."*** (p. 1047; emphasis added)
- [I]t is hard to have tremendous confidence in our ability as scientists to accurately project the complex dynamics of forest growth, wood use, harvest, land-use change, management intensity, forest policy, disturbance, and other factors influencing surplus growth, even at relatively short (<10 years) time periods and even on a national basis."
- "Given the challenges in predicting the future status of forest resources, . . . constant reference baselines might be more appropriate for monitoring and regulatory frameworks."

Data Limitations, Scale and Timeframes

We also would like to raise some additional points for the SAB to bear in mind. First, a reference point baseline approach should utilize the data of the U.S. Forest Service Inventory and Analysis (FIA) program, but its limitations must be recognized. For many years, AF&PA has supported increased funding for the FIA program, but currently data collection in the western part of the U.S. only occurs on a ten-year cycle. Ten years of measurements provide an estimate of average conditions at the midpoint of the cycle. For reliable detection of change, another cycle of data collection would be needed, but would only be completed 15 years after the midpoint of the initial cycle.

When comparing measurements against any baseline, it is important that only statistically significant differences are recognized, to ensure that policies are not based simply on random chance or sample variability. The smaller the region and the shorter the timeframe, the more uncertain the projections become. Moreover, larger regions and timeframes mitigate the influences that transitory factors, such as the housing cycle, weather and forest age, have on carbon stocks.[2] We are concerned that the

1 Thomas Buchholz, Stephen Prisley, Gregg Marland, Charles Canham and Neil Sampson, "Uncertainty in Projecting GHG Emissions from Bioenergy," Nature Climate Change (Nov. 26, 2014): www.nature.com/articles/nclimate2418

2 See, e.g., Reid Miner and Caroline Gaudreault, "A Review of Biomass Carbon Accounting Methods and Implications," National Council for Air and Stream Improvement, Technical Bulletin No. 1015, (July 2013) ("Even in regions where long-term average forest carbon stocks are stable, there are periods during

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lookback period suggested in the SAB's draft report is too short to be practical and would complicate long-term planning for facilities that use biomass to generate energy, particularly if emissions factors vary sharply from one assessment period to the next.

Forest Products Manufacturing Residuals

Finally, we reiterate that paper and wood products manufacturers are the largest industrial producer and user of bioenergy, predominately from the biomass residuals that are integral and incidental to the forest products manufacturing process. On average, about two-thirds of the energy powering forest products mills is derived from biomass. The process of producing bioenergy from forest products manufacturing residuals is highly efficient, using combined heat and power technology to produce both heat and electricity to power the mills or supply electricity to the grid. This sustainable use of forest products manufacturing residuals for energy provides enormous greenhouse gas reduction benefits.

This conclusion is supported by an in-depth study conducted by the National Council for Air and Stream Improvement (NCASI),[3] entitled, "Greenhouse Gas and Fossil Fuel Reduction Benefits of Using Biomass Manufacturing Residuals for Energy Production in Forest Products Facilities" (Aug. 2014). The NCASI study examined the life cycle greenhouse gas and fossil fuel reduction benefits of using biomass residuals for energy production in the U.S. forest products industry.

Key findings of the study include:

- There are substantial greenhouse gas reduction benefits associated with using biomass manufacturing residuals for energy in the forest products industry. Accounting for fossil fuel displacement and avoided emissions associated with disposal, the use of biomass residuals each year avoids the emission of approximately 181 million metric tons of CO_2e.

- The benefits of using biomass residuals for energy have been rapidly realized:
    - The greenhouse gas reduction benefits are realized in 1.2 years or less.
    - Even if the benefits of displacing fossil fuels are ignored, the use of manufacturing residuals for energy produces lower cumulative greenhouse gas emissions, with a weighted average break-even time of 7.6 years.
    - When considering its ongoing production and use of biomass energy over many years, the U.S. forest products industry is producing net greenhouse gas benefits by using biomass as its major energy source.

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which stocks may increase or decrease for a variety of reasons including market dynamics and natural disturbances. The time used to judge the stability of forest carbon stocks, therefore, must be long enough so as to avoid being misled by transient conditions that may not be important in the longer term.")

[3] The National Council for Air and Stream Improvement is an independent, non-profit research institute that focuses on environmental and sustainability topics relevant to forest management and the manufacture of forest products. http://ncasi.org/Downloads/Download.ashx?id=9603

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- If the U.S. forest products industry did not use biomass residuals and relied solely on fossil fuels for energy, the ultimate direct releases of greenhouse gases approximately would quadruple.

These findings underscore the importance of recognizing the carbon benefits of the forest products industry's use of biomass energy, regardless of the state of forest carbon stocks.

It has been over eight years since EPA began its deliberations on biogenic carbon accounting. We hope that our participation and comments over the years have been helpful in EPA's efforts to resolve the regulatory uncertainty regarding biogenic CO_2. Thank you for your consideration of these comments. If you have any questions, please feel free to contact me or Stan Lancey (202-463-2700) on my staff.

Respectfully submitted,

Paul Noe
Vice President for Public Policy
American Forest & Paper Association
American Wood Council

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Comments to the SAB on 8-29-18 Draft Quality Review of EPA's Biogenic C Accounting Framework

Mary S. Booth, PhD
Partnership for Policy Integrity

Shaye Wolf, PhD
Center for Biological Diversity

September 19, 2018

Introduction

The Partnership for Policy Integrity and the Center for Biological Diversity appreciate the opportunity to submit comments on the SAB's latest review of EPA's 2014 Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources. We have been involved with this process for about 8 years now, and commented extensively. Progress in making the framework and the assessment by the Biogenic C Panel and the SAB scientifically defensible has been hard-won. This draft contains significant improvements over the last version, particularly with regard to the timeframe issue, which is obviously a question of policy. It is also good to see that the report rejects use of the sprawling economic models (such as FASOM) that previous drafts had relied upon. Unfortunately, however, there are still some vestiges of the former report that confuse its message and contradict the advances that this version has made. The following comments are not comprehensive, but they provide a guide to the aspects of the report that should be changed or eliminated. The report can probably be shortened by another 25% or so, once certain sections are removed.

The SAB critique should acknowledge that the Framework is not fit for purpose, because it is not suited for evaluating net emissions from individual biomass facilities

Earlier reviews of EPA's Framework have continually complained that EPA did not provide enough guidance on how the framework is to be used. But it is right there in the title: "FRAMEWORK FOR ASSESSING BIOGENIC CO2 EMISSIONS FROM STATIONARY SOURCES." As the present document states at p. 6, *"For its review of the 2011 Framework, the SAB requested and was given a policy context for the biogenic CO2 accounting framework. The SAB was told that the 2011 Framework was intended to guide the determination of CO_2 emissions from regulated stationary sources under the Clean Air Act, specifically those facilities receiving a prevention of significant deterioration (PSD) air permit and that were required to conduct a best available control technology (BACT) analysis for CO_2 emissions. The question before the agency, and hence the SAB, was whether and how to consider biogenic greenhouse gas (GHG) emissions in reaching thresholds for permitting and decisions about BACT for CO_2 emissions from bioenergy."*

EPA was clear about the intended purpose of the framework. Yet while the alternative framework that was proposed by the Biogenic C Panel *could* be used to assess emissions at a single facility, this capability has been downplayed in the current document, which has removed all the modeling and scenarios from the previous draft. The present SAB report instead emphasizes the need for big, sweeping approaches to characterizing mass carbon flows at the

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"landscape" and "regional" levels (without really saying what this means, in terms of actual scale). Rather than taking this opportunity to put the framework back on track and strengthen its practical utility as a tool EPA can actually use, the advice given by the SAB nearly *rejects* the possibility of using the framework at the facility scale. This is especially ironic given that since 2011 when EPA published its first version of the framework, there have been a number of models published that evaluate net bioenergy emissions at the scale of an individual facility.[1] Unfortunately, the SAB evaluation cites almost none of these papers.

Example of the need for single-facility modeling: Imagine a single new wood-burning power plant is built in New England. It burns 900k tonnes of wood a year, and accordingly emits just over 900k tonnes of CO_2 at the smokestack. It needs an air permit for CO_2 emissions, but (in this imaginary world) EPA wants to write the permit for the "net" emissions, not the stack emissions. Or perhaps this facility is going to be regulated by a carbon-trading program, and policymakers want to charge it for allowances representing net carbon emissions, rather than stack emissions. In both these cases, policymakers would want to know what proportion of each tonne of carbon emitted at the smokestack represents net carbon added to the atmosphere. These are decisions that have to be made up front, when the air permit is written during plant construction, or when the plant is brought under the carbon trading program. To assess net emissions requires some knowledge about the facility's "fuelshed"; estimates of typical standing biomass for fuelshed forests; and typical BAF's for fuels burned (which as the cover letter to the report states, reflect "*a biogenic feedstock's net carbon emissions after taking into account its sequestration of carbon in regrown biomass or soil and emissions that might have occurred with an alternate fate had the biomass not been used for fuel.*"). With such information it is possible to develop a weighted estimate of the facility's net carbon emissions.

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[1] Booth, M. S. (2018). "Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy." Environmental Research Letters **13**(3): 035001.

Buchholz, T., J. S. Gunn and D. S. Saah (2017). "Greenhouse gas emissions of local wood pellet heat from northeastern US forests." Energy **141**: 483-491.

Hudiburg, T. W., B. E. Law, C. Wirth and S. Luyssaert (2011). "Regional carbon dioxide implications of forest bioenergy production." Nature Climate Change **1**: 419.

Laganière, J., D. Paré, E. Thiffault and P. Y. Bernier (2017). "Range and uncertainties in estimating delays in greenhouse gas mitigation potential of forest bioenergy sourced from Canadian forests." GCB Bioenergy **9**(2): 358-369.

McKechnie, J., S. Colombo, J. Chen, W. Mabee and H. L. MacLean (2011). "Forest Bioenergy or Forest Carbon? Assessing Trade-Offs in Greenhouse Gas Mitigation with Wood-Based Fuels." Environmental Science & Technology **45**(2): 789-795.

Mitchell, S. R., M. E. Harmon and K. E. B. O'Connell (2012). "Carbon debt and carbon sequestration parity in forest bioenergy production." GCB Bioenergy **4**(6): 818-827.

Walker, T., P. Cardellichio, J. S. Gunn, D. S. Saah and J. M. Hagan (2013). "Carbon Accounting for Woody Biomass from Massachusetts (USA) Managed Forests: A Framework for Determining the Temporal Impacts of Wood Biomass Energy on Atmospheric Greenhouse Gas Levels." Journal of Sustainable Forestry **32**(1-2): 130-158.

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In fact, the emphasis on characterizing mass landscape scale carbon fluxes, and the advocacy for the "reference point" approach, come perilously close in our opinion to reinforcing common biomass industry talking points that bioenergy has net zero emissions. These myths are given their ultimate expression in the current EPA policy just enacted under Pruitt, of treating all biomass from "managed forests" as "carbon neutral." This shameful policy is the ultimate culmination of a policy that evaluates carbon flux at the regional level, obscuring the impacts of burning wood for energy under a general supposition that as long as growth exceeds harvest at the regional level, bioenergy carbon impacts are negligible (note, however, the Pruitt memo did not even require forests to be "sustainably" managed). Advocacy for the reference point approach, which was previously unequivocally rejected by the Biogenic C Panel, undermines the credibility of the report. This is unfortunate, because in the present climate of obfuscation of science and alternative facts, a document like this needs to be crystal clear in its scientific integrity, intent and execution.

Further, the document is hard to understand. We have worked on bioenergy carbon modeling for over ten years, and we have spent several hours poring over this document, trying to pull out its method and meaning. We are particularly concerned that members of the SAB who don't work in this field may sign off on the document, assuming their own lack of experience with carbon modeling is responsible for the fact they can't scry its meaning. Trust us: it's not you. Despite significant improvements in this draft, the document is still confusing and self-contradictory. We suggest that anything the SAB doesn't understand in this document should be cut.

Modeling of net emissions is a one-time thing – it can't be retroactively adjusted

In assessing net carbon emissions from individual power plants, EPA needs an approach that will allow it to model and project net emissions when the permit is written – i.e., before the facility is built. This means that all the modeling is done at one time – there is no going back to retroactively "adjust baselines" (as the report calls for), and little if any ability to conduct post-permitting monitoring and verification. EPA is not going to go into the "field" and collect data on how a facility is affecting carbon stocks on the ground; nor does FIA data on forest carbon provide the spatial or temporal resolution necessary to retroactively assess impacts of an individual facility. Carbon modeling to predict net emissions is likely to be one-time thing that is best conducted for an individual facility and the particular fuel mix within its fuelshed.

The document seems confused about landscape vs stand-level analyses

Exacerbating the confusion about assessing carbon stocks on the landscape versus assessing net emissions from a single facility, the document seems unclear about the relationship between "landscape-level" analyses and "stand-level" analyses. Despite the abundance of a number of published models that rely on sequential cutting and regrowth analysis of plots harvested for bioenergy to estimate net carbon emissions – i.e., "stand-level" analyses - the document states in several places that modeling *must* be conducted at the "landscape" level and that a stand-level analysis is not correct. For instance, at page 8 it states, "*Stationary facilities require a*

continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach. "It also states (p. 10) that *"Previous studies have shown that estimates of the effects of biomass harvest on carbon stocks depend on the spatial scale of consideration (stand level or landscape level)."*

This last sentence actually this violates a central premise of modeling – that the model should give consistent results no matter what scale is assessed. If you're getting different answers when you model at different scales, then you're not applying the model consistently.

In fact, as Figure 1 demonstrates below, a landscape level analysis done correctly should produce the same result as a stand-level analysis.

The scenarios in Figure 1 conceive of the landscape as an assemblage of plots. In this simple example, the goal is to generate a BAF for biomass sourced from cutting trees. Trees are cut for fuel in the biomass scenario, and trees continue growing in the counterfactual scenario. We want to know the cumulative difference in carbon stocks between the two scenarios, which informs the BAF. Each plot contains 100 tonnes of carbon. Each year a plot, or a set of plots, is cut for fuel, resetting aboveground stocks to zero. Plots then regrow, adding one tonne of carbon per year (actual regionally specific regrowth estimates can be obtained using forest programs such as the Forest Vegetation Simulator, which uses FIA data). This analysis calculates the difference in carbon stocks between the two scenarios at Year 4. This example demonstrates that it doesn't matter if you compare the whole landscape to its counterfactual, or just those plots that have been cut - the carbon impact, calculated as the difference between the scenarios, is the same.

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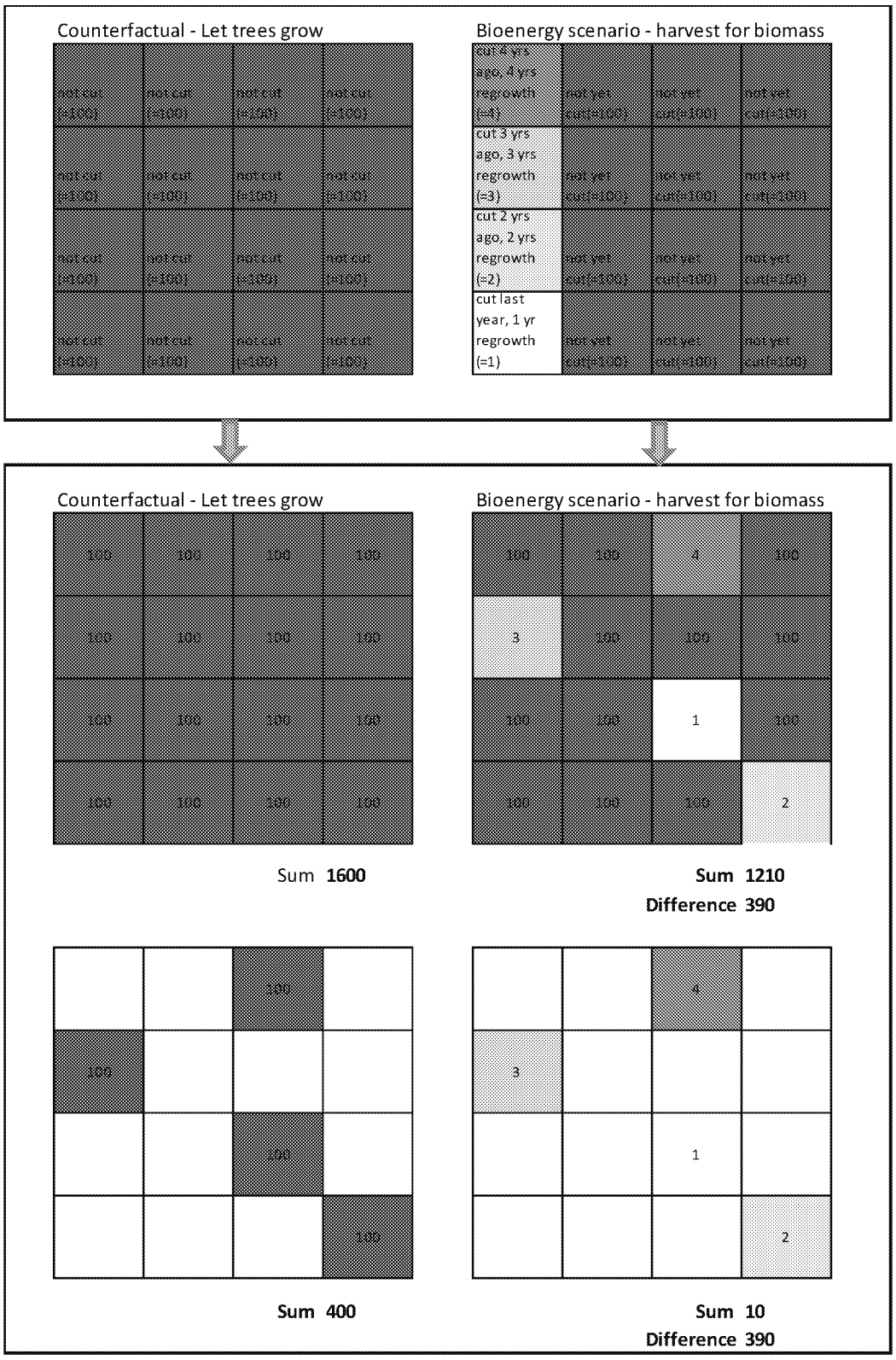

Figure 1a. It doesn't matter if you compute the difference between the bioenergy and counterfactual scenarios for the whole "landscape," or just those plots that are affected by biomass harvesting – the difference in carbon stocks is the same.

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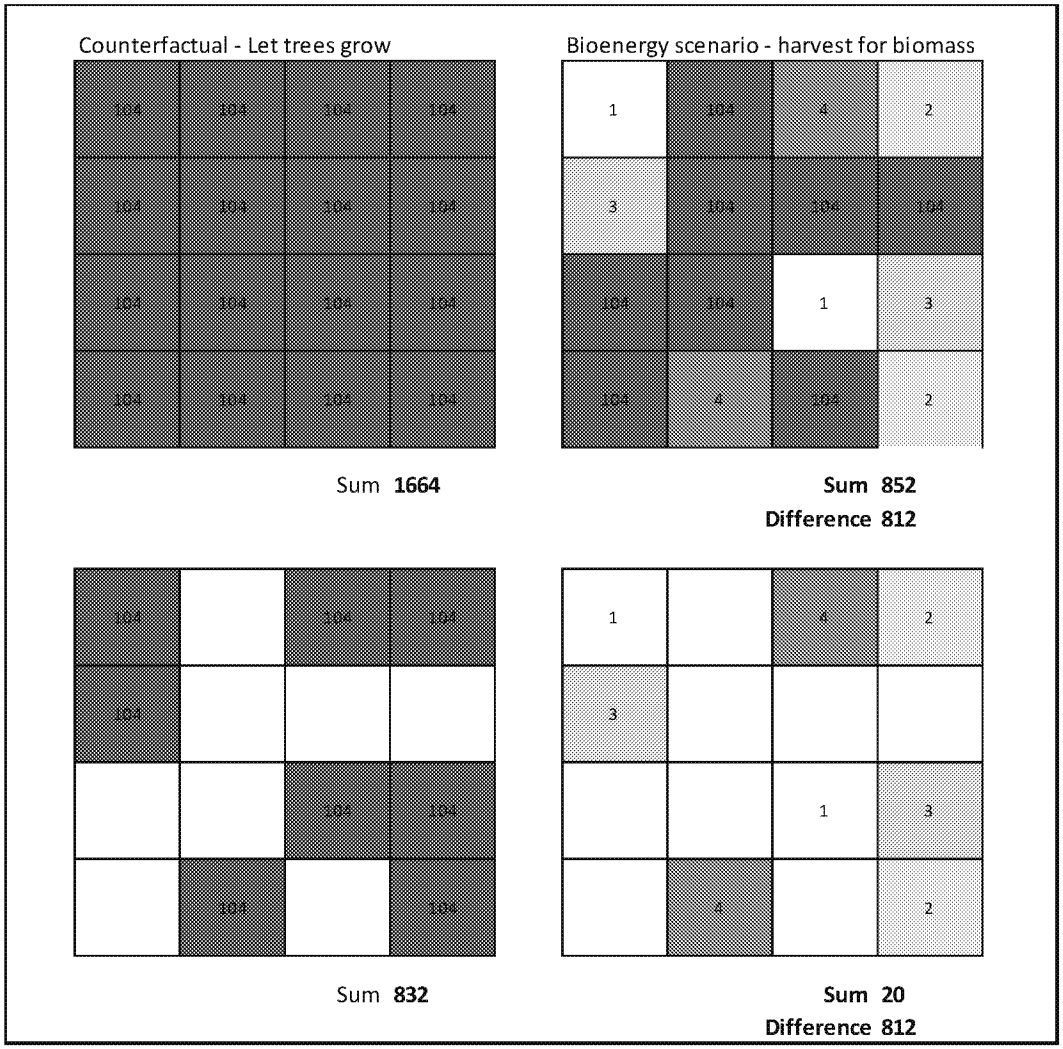

Figure 1b. This version continues "growing" the uncut plots over the four years, incrementing them by one tonne of carbon per year. It also doubles the number of plots that are cut for biomass each year. Again, it doesn't matter if you compute the difference between the bioenergy and counterfactual scenarios for the whole "landscape," or just those plots that are affected by biomass harvesting.

There are several things we can observe from this example.
First, as already stated, since we are interested in the difference in the two scenarios, it is not necessary to model data for every plot on the landscape – only those plots that are affected by biomass harvesting.

Second, while the report states (p. 11) that *"Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed in a regulated manner (i.e., completely asynchronously),"* and therefore, *"stand level accounting is not relevant to the calculation of*

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BAFs," in fact, sequential analysis that accumulates the effect of harvesting and regrowth of individual plots through time is preferable, because it makes it clear that each plot is "responsible" for re-sequestering equivalent carbon that was released when that plot was cut (there are more problems with the statement from p. 11, as discussed below). However, the model does not need to know *where* on the landscape that forest cutting for biomass happens (i.e., the model does not have to be spatially explicit). While it is helpful to have specific data on plot-level carbon stocks, it is not necessary – an average standing carbon estimate for a facility's fuelshed, plus its regrowth rate, can be used to generate robust modeling results.

Third, you *do* need to know what the types of fuels are (residues versus whole trees, for instance) and the rough amounts burned, because this matters to plant-level net carbon emissions (a weighted average of the BAFs of the fuels burned).

Discussion of "landscape" BAF is incorrect

The cover letter to the document defines the BAF as reflecting *"a biogenic feedstock's net carbon emissions after taking into account its sequestration of carbon in regrown biomass or soil and emissions that might have occurred with an alternate fate had the biomass not been used for fuel*." It is clearly a feedstock-level metric, appropriate for a plot-level analysis.

Yet the framework, and the present document's critique of it, seems to want to develop a BAF for an entire landscape containing all the different types of fuels. At p. 15, the document states *"A shifting projection of the reference baseline that includes a historical time period could be used to reset the baseline periodically based on re-measuring carbon stocks on the landscape, using data from existing inventory programs. This would improve the accuracy of the baseline over time. Future changes in growth-to-harvest ratios could be used to inform the model assumptions and modify the BAF that would be applicable going forward."*

It is not appropriate to assign a BAF to a landscape. Carbon stocks on the whole landscape are affected by climate, drought, land clearing, harvesting for biomass, harvesting for every other wood product, bugs, and fire. Comparing an anticipated no-bioenergy baseline scenario with bioenergy scenario to a unitary landscape, which contains some or all of the fuels to which BAFs are properly assigned, is impossibly complex and essentially meaningless. The deterioration of the BAF concept from one crisply defining carbon impacts of particular types of biomass, as explained in the cover letter, to one imprecisely and inexplicably applied to entire landscapes, actually makes the document incoherent.

Fuel-specific BAFs do not require information about the amount of fuel harvested

The document is imprecise about the information required to generate a BAF. At p. 16 it states, *"If the EPA's goal is to obtain a region-specific BAF for a feedstock, it will be necessary to project region-specific and feedstock-specific demand for biomass*."

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Here, it is clear that the BAF applies to a feedstock, not a landscape, so that is good; it is also legitimate to develop regionally specific BAFs for different fuels, because trees grow at different rates, and residues decompose at different rates, depending on the region. However, it is not necessary to know biomass demand to develop fuel-specific BAFs. You don't need to know how many tonnes of trees will be cut down for biomass to determine the difference in carbon stocks between an uncut stand and one that's been harvested – it's a per-acre metric and what is true for the first stand will be true for all the others.

The discarded "reference point" returns in a new incarnation – but should be abandoned for good

The reference point approach, which was largely rejected by the SAB in previous incarnations of its review, has reappeared in this version of the document. The 2-18-2016 version of the SAB's draft report expresses strong reservations about the reference point approach, p. 10: "*To compare change in any system over time, there must be a baseline against which to assess changes so that two distinct scenarios can be compared. The EPA's reference point baseline approach simply assesses the estimated net change in land-based biogenic CO2 fluxes and/or carbon stocks between two points in time. In our 2012 SAB report, we stated that the* ***reference point baseline approach is inadequate*** *in cases where feedstocks accumulate over long time periods because it* ***does not estimate the additional effect of a stationary facility's combustion of biomass on carbon emissions over time****. The EPA has acknowledged this limitation in its 2014 Framework and now includes a future anticipated baseline analysis alternative along with a reference point approach.* ***The SAB remains concerned that the reference point approach has important limitations and should not be the preferred approach.***"

Page A-4 of that 2016 SAB report explains the objections of the Biogenic C Panel to the reference point approach: "*The SAB Panel expressed concern that the reference point baseline* ***does not address the important question of additionality****, or what would have been the trajectory of biogenic CO2 stocks and fluxes in the absence of an activity or activities using biogenic feedstocks for energy, especially in the context of forest-derived feedstocks. '****Estimating additionality****, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy,* ***is essential****, as it is the crux of the question at hand.* ***To do so requires an anticipated baseline approach'****" (SAB Letter, p. 2)."*

However, despite these warnings as to the total inadequacy of the reference point approach, it has persisted and even evolved in the present document, which newly states at p. 2, "*The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks*." At p. 16, the document formally recommends adopting the discarded approach: "*The SAB suggests consideration of two cumulative BAFs—that proposed by EPA and an alternative metric that takes into account the changes in terrestrial carbon stocks over time. The appropriate cumulative metric for calculating BAFs will depend on the understanding of the carbon system and climate response for which there is uncertainty*."

(we are unclear what that last sentence means. What is the metric that would determine which approach to use?)

This is a big problem. First, the reference point approach, which compares carbon stocks between two points in time on a landscape, is incapable of truly assessing the carbon impacts of bioenergy, as the SAB and Panel have noted. It is also incompatible with the feedstock-level BAF approach that is endorsed elsewhere in the report, which can be used to determine net emissions from biomass facilities.

Second, when comparing carbon stocks on the landscape between two points in time under the reference point approach, what is to be done about all the other things that affect carbon stocks – harvesting, planting, landuse change, fire, drought, pests… how is the bioenergy "signal" to be determined?

Third, "adjustment" (of what we're not told) to "account for additional regional sequestration" will not address the problems with the reference point approach. Nothing about this solution addresses the fact that the reference point approach does not take into account the trajectory of forest carbon stocks in the absence of biomass harvesting. As the Biogenic C panel and the SAB have pointed out, *"Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy,* ***is essential, as it is the crux of the question at hand****. To do so* ***requires*** *an anticipated baseline approach."*

The Biogenic C Panel, which has literally worked on this issue for years, was very clear in their rejection of the reference approach. To ensure the scientific credibility of the report, the SAB should reject the approach as well.

The document contains alarming echoes of biomass industry talking points

In some places, the report is clear that fuel harvesting generally involves net emissions that are gradually offset as plots regrow. Yet the report still retains biomass industry talking points that claim carbon neutrality for biomass as long as net growth is positive. For instance, at p. 11, the document implies that a landscape analysis is necessary because too much is happening at the same time (p. 11): *"Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed in a regulated manner (i.e., completely asynchronously), and the order in which losses and gains occur becomes meaningless at the landscape level because both simultaneously occur; thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing."* (similar language at p. 9).

First, an important note: while the document states "stand-level accounting is not relevant to the calculation of BAFs," that's true – but it's true because a BAF is scale-free. E.g., to use the example from above, the difference in carbon stocks on a per-acre basis between a harvested,

now re-growing forest, and a forest that's never been cut, is going to be the same for one acre, or 100 acres.

Second, this language is misleading because it implies that sequestration occurring on plots cut in previous years is credited with offsetting the carbon released by current fuel-burning (which would be double-counting). It is particularly alarming to see the phrases *"the operative issue is the overall balance between losses and gains of carbon at the landscape scale," and, "if harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing,"* because this language is so similar to language from an article co-authored by Jennifer Jenkins, who authored the first version of the EPA framework but now works for Enviva, the largest wood pellet manufacturing company in the world.[2] In her job at Enviva, Jenkins routinely claims things like *"Energy from biomass harvested from managed working forest landscapes where growth outpaces harvest is zero-net-carbon energy,"* because *"For a working managed forest landscape, at any given time, across all the different stands that make up that landscape, the forest is yielding emissions from those units being harvested while simultaneously sequestering carbon as a result of new growth and regeneration in other units harvested previously."*[3] Sound familiar? This is similar to the language found in the SAB report. It is absolutely in the interest of the wood pellet industry to be able to claim that as long as forests show net positive growth, bioenergy has no net emissions. This is a seductive concept, but one that the biogenic C panel and the SAB have already rejected. We strongly suggest that this language be removed from the SAB report.

Such an approach is incompatible with science-based carbon accounting that counts emissions and sequestration separately, and is incompatible with the SAB's own definition of the BAF as reflecting *"a biogenic feedstock's net carbon emissions after taking into account its sequestration of carbon in regrown biomass or soil and emissions that might have occurred with an alternate fate had the biomass not been used for fuel"* – a definition that clearly requires each plot to be "responsible" for re-sequestering equivalent carbon as was released by its earlier harvest. This objectionable section on p. 11 (and p. 9) should simply be deleted to avoid flirting with the fallacy that bioenergy emissions can be "instantaneously carbon neutral" due to carbon uptake occurring "somewhere", a favorite bioenergy industry claim.

It is also alarming to see the document refer to "growth to harvest ratios" as a modifier for BAFs (p. 15), as if this metric is somehow relevant to the carbon impacts of bioenergy. This is a biomass industry talking point (bioenergy should be treated as having net zero emissions as long as growth exceeds harvest). It does not belong in a scientific report.

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[2] In retrospect, EPA asking Jen Jenkins to craft the biogenic C framework was like having Michael Flynn design your election security plan.

[3] https://www.energycentral.com/c/ec/climate-solution-we-cannot-afford-ignore-biomass-sourced-naturally-managed

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Document needs to be edited for confusing economic modeling jargon

Despite rejection of large complex economic models (which is good) the document retains vestiges of Big Modeling jargon from previous incarnations. For example, at p. 1 it states, "*In general, the BAF for a class of feedstock should be estimated for the average effect of the last increment of demand for that feedstock*."

It is not clear: Why is this statement here - just generally, why should this be true? There are a number of published models that calculate net carbon impacts of biomass without resorting to economic gimmickry around "increments" of feedstock. Further, this statement does not really make sense. How can *one* increment of feedstock have an "average effect"? Wouldn't the "average" effect refer to the average of *many* increments of feedstock, leading up to that point? And what is the "last increment," anyway, given that biomass plants demand fuel on an ongoing basis in order to operate?

The document should be stripped of all such jargon and all necessary remaining concepts expressed in a simple way so that special economic or modeling expertise is not required to understand the meaning.

More confusion arising from economic modeling

Another vestige of the economic modeling approach is the incorporation of unjustified assumptions about how facilities operate (consistent with the "rational operators" that economic models assume). For instance the following at p. 17: *"In the absence of a mandate for use of specific feedstocks or incentives for specific types of bioenergy which might be prescribed in a policy framework, and which would inform the feedstock-specific demand that should be modeled, a reasonable approach is to model the aggregate demand for feedstocks.* ***This approach assumes facilities are constantly seeking their least-cost alternative.*** *An aggregate demand could be imposed on the model and used to determine demand for different feedstocks in different regions. This would allocate demand across feedstocks as well as within each category to simulate a given target aggregate demand determined by the market's ability to draw from the least cost combination of feedstocks."*

This is not realistic. While of course bioenergy operators seek the lowest-cost fuels, they don't burn just whatever fuel becomes available. Wood burning power plants cannot switch to burning corn stover, for instance, without significant adjustments to their operation and emissions controls. All such assumptions – and remaining references to large economic modeling efforts – should be carefully vetted or removed.

No acknowledgement of methane from fuel piles

Finally, one small but important point. Methane emissions have been shown to be significant from wood chip piles at biomass plants, as well as wood pellet storage and transport. The report talks about the importance of including methane emissions in counterfactual scenarios (e.g. "methane emissions for woody mill residuals," p. 2), which would presumably make burning

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materials for biomass look more climate-friendly by comparison, but does not mention that collecting wood from the forest and storing it in enormous piles at biomass plants may itself be a source of emissions (some citations at http://iopscience.iop.org/article/10.1088/1748-9326/aaac88).

Thank you for the opportunity to comment.

Mary S. Booth
Director, Partnership for Policy Integrity

Shaye Wolf
Climate Science Director, Center for Biological Diversity

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COMMENTS ON PROPOSED SAB BIOGENIC CARBON REPORT (2018)

Philip B. Duffy, Timothy D. Searchinger[1]

(September 18, 2018)

These comments are supposed on the proposed report of the EPA Science Advisory Board released August 2018 regarding the accounting of greenhouse gas emissions from biogenic carbon. Because this report focuses overwhelming on forest-based biomass, we limit our comments to that topic. The authors of these comments have extensive experience and academic writings evaluating bioenergy in the Executive Branch and in academic writings. Although time limitations prevented a broader effort at coordination, these comments are also consistent with comments submitted by dozens of scientists and economists prior to the last proposed biogenic carbon report for the SAB in March of 2014. (An extended version of those comments is attached as Appendix B.)

Although the new proposed report is an improvement over the last two panel report drafts – particularly in its discussion of timing – the language contains three somewhat related problems which should be corrected:

(1) The report in places could still be read as recommending accounting, including forms of the "reference baseline" that commingle the effects of harvesting wood for bioenergy itself and exogenous effects on forest carbon of other activities and natural fluctuations and therefore assign undue GHG savings or costs to bioenergy that are unrelated to the effects of bioenergy itself.

(2) The report encourages potential use of a class of models, economic models, that (a) are inappropriate and unprecedented for the types of regulatory purposes at issue here; (b) have never been validated and are recommended by the SAB without any analysis of whether they could be valid or validated; and (c) include specific reference to models that are not empirically based but are thought exercises in which the more favorable results for bioenergy are hardwired into the modeling assumptions.

(3) The report could be read as suggesting that a single emission factor (BAF) for forest biomass feedstocks be calculated regionally, which would both unfairly benefit high carbon sources of biomass and unfairly penalize low carbon sources of forest biomass, such as wood product wastes.

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[1] Philip Duffy is the President and Executive Director of the Woods Hole Research Center. Prior to joining WHRC, Dr. Duffy served as a Senior Advisor in the White House National Science and Technology Council, and as a Senior Policy Analyst in the White House Office of Science and Technology Policy. Dr. Duffy has held senior research positions with the Lawrence Livermore National Laboratory and visiting positions at the Carnegie Institution for Science and the Woods Institute for the Environment at Stanford University. He has a Ph.D. in applied physics from Stanford. Tim Searchinger is a Research Scholar at Princeton University's Woodrow Wilson School. Searchinger has authored a dozen papers on the carbon accounting of bioenergy, including four papers in *Science.*

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In Appendix A we provide specific recommendations for changes in language to address these concerns.

I. Importance and likely consequences of using wood deliberately harvested for bioenergy

For decades, the world has long burned wastes from the production of other wood products for energy, and there is broad agreement that such bioenergy reduces carbon in the atmosphere because it saves fossil fuels without adding carbon to the atmosphere that would not occur anyway and quickly through decomposition. The controversy today concerns efforts to harvest wood deliberately to burn for bioenergy.

In January of this year, roughly 800 scientists and economists submitted a letter to the European Parliament warning that going beyond wastes and instead harvesting wood to burn for bioenergy – including portions of trees otherwise used for wood products – would likely double or triple the quantity of greenhouse gases added to the atmosphere by 2050 for each energy unit of fossil fuels displaced.[1] This letter was written by winners of the U.S. Medal of Science and the Nobel Prize, a former Chief Scientist of the United Kingdom, multiple members of the U.S. and European National Academies of Science, and numerous leaders of the IPCC. They based their work on abundant, peer reviewed papers of biophysical models, which have analyzed the harvest of wood for bioenergy from a wide range of forests, using a wide range of harvesting strategies, a wide-range of processing strategies, and replacing a variety of different fossil fuels. [2–12] Numerous other scientific bodies have reached similar conclusions, including the combined European national academies of science in a recent analysis.[13]

These scientists have also warned that the consequences for forests and the climate of pursuing forest-based bioenergy are likely to be large because it requires a vast quantity of wood to produce a small quantity of energy. For example, all the wood harvested annually in Europe, which roughly matches the annual wood harvest of the U.S. and Canada, could at most generate roughly 5% of Europe's annual primary energy demand.[14] In the U.S., all annual US wood harvest could supply 3-4% of U.S. annual primary energy. On a global basis, all commercial wood harvests (wood that is not already harvested for traditional household fires and charcoal) could supply only 2% of global primary energy.[14] Although developed countries have long used the black liquor and other wastes of wood product generation, which still today supplies the bulk of developed world bioenergy, any move toward directly harvesting wood to burn has high potential to cause vast harm to the world's forests, their ecologies, and their carbon stocks without contributing significantly to our energy supply.

The reasons for the high GHG consequences of dedicated wood harvests for bioenergy are intuitive and explained in plain language in that 800-scientist letter and in a recent, peer-reviewed paper in Nature Communications by some of the letter's authors.[14] Wood is an inefficient carbon-based fuel from a GHG perspective. Its harvest necessarily and properly results in much of each tree, such as roots and some small branches, being left to decompose in

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the forest which releases carbon without any offsetting savings in fossil fuels. Burning wood is also inefficient compared to using fossil fuels, particularly for electricity due to the nature of its carbon bonds and water content (and any effort to make the wood more efficient by compressing it into pellets loses more wood and generates other energy emissions). Although wood is renewable and could regrow, most forests harvested for wood would also continue to grow (and sequester carbon) for many years faster than a newly re-growing forest. Eventually, the combination of saved fossil fuels and re-growing forests will pay off the carbon debt on the first stand harvested, but it will take more years to pay off carbon debt on additional stands harvested in subsequent years. Overall, according to multiple estimates by multiple authors of multiple independent researchers, and despite variations in the details, it will take decades to centuries for wood harvested directly for bioenergy to even match the emissions of fossil fuels and many more years to generate substantial carbon savings.[2–12] All of this of course assumes that forests are maintained as forests, and there is no reason that has to be true.

This conclusion should be no surprise to anyone who recycles used paper. Three decades ago, this country went through a major debate regarding whether it was better to recycle used paper or to burn it for energy. The correct conclusion was that recycling was better for the environment largely because it saved the trees otherwise devoted to paper production. The recommendation of some to burn wood directly as a whole uses wood of pulpwood quality, precisely the wood saved by recycling, and is in effect a recommendation that the country should burn the trees saved by the recycling efforts of tens of millions of Americans (and potentially far more trees too). Any analysis that claimed to justify such efforts on GHG consequences should also show claim that the recycling of used paper is an environmental (or at least GHG) mistake. For the reasons described in the previous paragraph, it is not.

However, it is important to recognize that this finding does not mean that there are no possible increases in forest-based bioenergy. If additional wood in the future were harvested for wood products, e.g., for construction, which could occur because of market forces or even because of some climate strategies to replace steel or concrete, that process will generate more forest-based waste for bioenergy use. For this reason, it is also important that bioenergy accounting distinguish among different sources of biomass.

II. Commingling of Exogenous and Endogenous Effects

The greenhouse gas emissions from bioenergy can be accounted for by examining the changes it causes in terrestrial carbon storage (just as fossil fuel emissions could in theory be counted by changes in underground carbon storage.) If that is done, a critical factor sound accounting is to separately account only for the changes caused by bioenergy and not commingle it with exogenous changes. This very simple distinction between analyzing the "consequences" of bioenergy and exogenous forces explains why the first full SAB report rejected EPA's proposed use of the so-called "reference baseline." The essence of the SAB's first biogenic carbon report based on the 2011 proposed EPA framework was that the proposal from the agency would commingle effects of bioenergy and other changes in forest carbon. It would

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thereby improperly credit carbon savings to bioenergy that would occur independently and possibly sometimes possibly improperly assign carbon costs that were not caused by bioenergy.

The basic point is simple: all analyses of any discrete action, whether bioenergy or any other, need to segregate the effects of that action from exogenous effects. The problem with EPA's reference baseline is that it commingles these effects. In part to assure this distinction is clear, we recommend that the report include explicit language about distinguishing the effects of bioenergy from other effects and provide some suggested language in our appendix.

EPA originally recommended a so-called "regional reference baseline" approach, which if we understand correctly, meant that in each region EPA assumed that any future harvest of wood that did not reduce carbon stocks below the existing baseline would be deemed to be carbon neutral. That commingles the effects of bioenergy production and the effects of exogenous factors. In particular, the world as a whole and most regions, including the United States, are gaining forest carbon. [9] This sink adds roughly one gigaton of carbon every year to the world's forests and therefore removes that amount of carbon from the atmosphere. Under the "regional reference baseline" approach, enough wood could be harvested for bioenergy to entirely negate this sink, and that would be considered "carbon neutral." Ton for ton, removing wood and burning it adds carbon to the atmosphere regardless of whether there would otherwise be an exogenous net sink or an exogenous net loss.

Other exogenous effects are also commingled in this baseline, which could either unfairly and inaccurately advantage or disadvantage bioenergy GHG calculations. For example, what if a forest area is experiencing decreasing carbon stocks due to other wood harvests? That does not mean that using all forest biomass is incrementally harmful for the climate, and the prominent example is the use of wood wastes from wood production. If those wastes were going to decompose quickly anyway, using them for bioenergy does not add carbon to the atmosphere over a policy-relevant time line and that is true regardless of whether regional forests are gaining or losing carbon stocks without bioenergy. Alternatively, a reference baseline may build in an existing level of wood harvest, and that harvest may decline in the future for any of a number of reason, such as a slowdown in the US housing market and an influx of cheap imports. This increase in carbon would not be created by the bioenergy and would increase carbon stocks without bioenergy. Again, the bioenergy harvest would increase carbon in the air although it would be inappropriately credited with the carbon gains from this exogenous market change.

It is for these reasons that the SAB's previous report found the use of a reference baseline to be fundamentally inaccurate and recommended instead an anticipated baseline approach. Although the terminology of an anticipated baseline may be unnecessarily complex, the key point is to compare bioenergy with the lack of bioenergy alternative. Tthe standard way in which multiple researchers have modeled the effect of bioenergy is to analyze the different kinds of forests and individual trees potentially harvested using biophysical growth models to compare their carbon stocks with and without the harvest and how those carbon stocks would

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change over time assuming forests are allowed to regrow. These papers generally use as landscape approach by examining the removals that will occur over time across the landscape.[3]

Our concerns with the new report are that it appears to resurrect problems the previous report was designed to prevent. Some of this language may be inadvertent. For example, on page 11, line 8, the report reads: "If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing." This language is problematic because it might be read as implying precisely that bioenergy harvests could expand to a level that eliminates a forest's exogenous growth and therefore it carbon sink and this level of bioenergy harvest would be treated as carbon neutral. Appendix A to these comments goes through the text line by line and suggests deletions or modest additions to insure that the focus is on the incremental effects of the bioenergy harvest.

The most problematic language is on page 2 in language that explicitly resurrects the reference baseline approach without justification: It states: "The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks."

We fail to see how mere adjustment over time of the reference baseline addresses the problem of commingling endogenous and exogenous effects. The reference baseline, as EPA has defined it, is the existing carbon stock at the time of the regulatory analysis. In other words, for a power plant permitted in 2018, the reference baseline applied regionally would be the carbon stocks of forests in the region. If the forest would grow and accumulate carbon over time without bioenergy (which is true of American forests as a whole due to the forest carbon sink), bioenergy would be allowed to expand up to the point that it eliminates this forest carbon sink. In fact, if the carbon stock is going to change for any reason just comparing the bioenergy harvest scenario with the carbon stock in place in 2018 cannot isolate the effects of the bioenergy harvest. In fact, in a region that is losing carbon for reasons unrelated to bioenergy, this approach would unfairly tar the bioenergy harvest with additional emissions it did not cause.

In addition, as a practical matter, we cannot see how adjustment of the reference level over time could alter the consequences. A power plant will be permitted based on an initial analysis. Is the report suggesting that if the carbon stock changes in five years, the permit should be rewritten? And what about the previous years? If they turned out to have been based on false premises, should the power plant be fined? If not, the original decision to allocate the forest carbon sink to bioenergy is permanent. If the power plant is fined, it could be blamed for changes in forest carbon that have nothing to do with bioenergy, such as poor growing weather or an increase in the U.S. housing market, stimulating further wood harvests for timber.

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This reference baseline could be an extremely large loophole crediting bioenergy that actually increases emissions with reductions because they are allowed to claim the exogenous forest carbon sink as a credit. For example, i this rule were applied globally, given the size of the global forest sink, it would allow a tripling of global commercial wood harvest.[14] Any valid scientific rule has to be valid everywhere.

The solution is always to focus on the incremental effect of the bioenergy harvest. That is best done using the methods employed in the many biophysical modeling papers identified in references 2-12. As noted, in Appendix A, we recommend specific language changes to delete the problematic language and to add the

III. Inappropriate and Not Validated Endorsement of Economic Models

The report endorses the potential use of economic, and not merely biophysical, models for analyzing the carbon consequences of bioenergy. The inappropriate use and lack of scientific support for these models was a major focus of joint comments submitted by dozens of scientists and economists to the SAB in 2014. Those comments also offered particular explanations about the FASOM model used by EPA. The new draft properly recommends against the use of the FASOM model as not validated but suggests that other, unspecified models might be used. For the following reasons, we recommend that this endorsement for the use of economic models in this context be deleted.

A. Inappropriate and unprecedented regulatory use

The economic models at issue, whose results tend to vary widely, incorporate into the analysis of bioenergy actions by other people and on other land claimed to be stimulated by increased prices caused by the addition of bioenergy demand for wood. For example, the model may estimate that use of wood for bioenergy diverts wood that would otherwise be used for paper and cardboard production and reduces their consumption, so that diverting that wood to bioenergy in effect reduces the loss of carbon due to their consumption. The model may also estimate that due to higher prices other landowners to manage forests more intensively to grow faster or even plant more forests. Both effects in and of themselves cause gains in carbon stocks, and the model counts those credits as offsetting losses of carbon due to bioenergy.

The best way to understand why this use of economic models to regulate power plants, factories and other "stationery installations" is inappropriate is to think of standard modeling of a steel plant. If a new steel plant is built, regulations always count its emissions, and not merely of CO_2 but of SO_2, NOx and other pollutants. Regulators do not run an economic model, estimate for example that the new steel plant will put an old steel plant out of business, or reduce its production, and then deduct those reduced emissions from the emissions of the new steel plant For the same reason, regulators also would not use an economic model that might estimate that the new steel plant will cause changes in other markets that might increase emissions from other sources and attribute those emissions to the steel plant.

Similarly, if a steel plant directly diverts coal from an existing mine that would otherwise go to another factory or power plant, regulators do not count that coal as emission-free on the theory that it would be burned anyway. They count the emissions from the coal and assume instead either that the other factories and power plants would burn replacement coal or just that by assigning responsibility to each user, regulators will ultimately have a more rational and comprehensive regulatory approach.

Regulation of stationery installations does not work this way because the best way to regulate is to hold each source accountable for its own emissions. The alternative structure also creates a high risk of double-counting. For example, if a landowner plants a forest, even if due to higher prices due to bioenergy demand, the credit is typically assigned to the landowner not the consumer of bioenergy. And for these reasons, we should assign the costs of the wood to the bioenergy user regardless of these economic effects. Regardless of such effects, bioenergy is using wood removed from the forest for bioenergy and bioenergy should be assigned any reduction in carbon stocks that directly result from that wood removal.

The point is not that such economic models, to the extent valid, could not have some policy uses. For example, policymakers might wish to run such a model to estimate rebound effects of policies in many contexts. Such analysis might work at the scale of evaluating entire regulatory programs. (There may even be some valid uses of such approaches in types of lifecycle analyses.) But the policy at issue here involves the accounting of emissions from stationary installations. There is no reason to treat bioenergy differently from any other source of fuel.

B. **The SAB has undertaken no analysis of the potential validity of these models.**

The use of some kind of model is inherent scientific calculations, but before the SAB recommends use of a class of models for regulatory purposes, it should carefully evaluate them and have a sound basis for determining that they could be sufficiently valid to be used for the regulatory purpose. That is particularly true when the SAB has received comments from distinguished economists and scientists to the contrary. We draw the SAB's attention again to comments previously submitted by economists and scientists and attached as Appendix C. The gist of these comments was: (a) that there are simply too many unknown parameters to construct an empirically grounded model of the kind that some others have been using to estimate biogenic carbon effects, and (b) that these models in part as a result also leave out critical effects that have the critical effect of assigning "free" biomass or land for bioenergy use, e.g., by assuming diverted wood products or diverted agricultural land are not replaced. Previous comments have also pointed out that to our knowledge, none of these models has been validated in any meaningful way.

Indeed, before an economist can claim validity for a predictive model, economists should at least be able to reproduce prior effects of changes in wood biomass demand using

proper econometric methods to isolate the effects of that demand. We are also not aware of any proper econometric studies that have validly analyzed such effects in the past.

Without careful analyses of these questions in this report, even if economic models were appropriately used for these kinds of regulatory purposes, we believe it would be inappropriate for the SAB to recommend their use.

C. The Cintas et al. paper cited is not a true economic projection but a constrained thought experiment in which the results are dictated by the assumptions.

The proposed report cites one "economic model" used by Cintas et al. [15], implicitly approves of it, and claims it establishes that bioenergy harvests for bioenergy can sometimes result in immediate forest carbon gains. But this model is not truly capable of making that prediction. In fact, this paper does a good job of illustrating what is going on in many other economic models that claim the potential for short-term GHG benefits. The assumptions built into the modeling in Cintas et al. can have favorable results for bioenergy because they require that additional wood harvest within a forest be offset by more intensive forest management or reductions in other wood consumption, both of which add to terrestrial carbon storage.

If we understand the modeling in that paper correctly, it models one defined area of forest only and three important assumptions: (1) all land within that forest area even without bioenergy will eventually be cut and is already managed optimally to generate economic returns, (2) the demand for additional wood for bioenergy continues indefinitely into the future, and (3) the additional wood for bioenergy cannot be produced by harvesting wood either in this forest that would otherwise not be cut (because it would all be cut anyway) or by harvesting wood from another forest that would otherwise not be cut. The effect of these assumptions is to preclude the possibility in the model that the increased demand for wood to meet the bioenergy demand would be met just by harvesting more trees that would otherwise not be cut. Because that new bioenergy demand is permanent and fixed, the only ways the model can meet this demand are for it to project that other forest owners will manage their land more intensively or that bioenergy will divert wood from other uses that are not replaced from the forest. These assumptions are just pure assumptions and not based on any empirical analysis.

The main options these analyses leave out is the option to provide wood for bioenergy just by cutting more trees that have grown and would grow anyway. On both global and most regional bases, there is no need to plant more trees or intensify wood production to meet increases in bioenergy demand because forest carbon stocks are growing. That is particularly true because bioenergy does not require straight trees, which is a typical goal of forest plantations. In addition, the assumption of a permanent increase in bioenergy largely precludes the model from estimating that forest owners would just cut more trees to meet a one-time or short-term increase in demand. In reality, not only are many forest bioenergy policies explicitly temporary but landowners are likely to discount any prospect of future bioenergy demand due

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to many inherent uncertainties and therefore likely to harvest more trees quickly to take advantage of a market opportunity that has no guarantee of long-term continuation.

This discussion illustrates how easy it is for modeling to be built on assumptions that are not empirically derived to drive results. (In fact, we believe that other economic models that also show relatively short-term benefits for forest-based bioenergy work through a similar approach.) It is not that the results in Cintas et al. are not interesting, but they are not grounded in any capacity to predict real, empirical consequences. The discussion of the results in Cintas et al. should be removed from the draft.

IV: The report should recommend distinguishing among different sources of forest biomass feedstocks

The use of different types of forest biomass will have different GHG consequences. Although the harvest of additional stemwood will likely increase carbon in the atmosphere for decades to centuries, the use of wastes from wood processing should decrease emissions quickly, and the use of true residues are likely to have intermediate effects.

Although unclear, there are places that the report could be read to endorse one GHG assessment for all forest biomass in a particular region based on (again) presumably economic projections of the likely types of forest biomass that will be used. In addition to other problems identified above, this approach would shape incentives incorrectly. It could make biomass from wastes that would achieve quick GHG reductions look worse than they are while making wood deliberately harvested to burn look better than they are.

We therefore recommend that the report explicitly recommend distinguishing among different types of feedstocks and it should calculate these emissions based on the harvests of wood actually supplying a particular facility.

References

1. Beddington, J. *et al. Letter from Scientists to the EU Parliament Regarding Forest Biomass.* Available at: https://empowerplants.files.wordpress.com/2018/01/scientist-letter-on-eu-forest-biomass-796-signatories-as-of-january-16-2018.pdf (2018).
2. Laganière, J., Paré, D., Thiffault, E. & Bernier, P. Y. Range and uncertainties in estimating delays in greenhouse gas mitigation potential of forest bioenergy sourced from Canadian forests. *GCB Bioenergy* **9,** 358–369 (2017).

ED_004741_00009101-00009

3. Mitchell, S. R., Harmon, M. E. & O'Connell, K. E. B. Carbon debt and carbon sequestration parity in forest bioenergy production. *Glob. Change Biol. Bioenergy* **4,** 818–827 (2012).
4. Stephenson, A. L. & MacKay, D. J. C. Life cycle impacts of biomass electricity in 2020. *UK Department of Energy and Climate Change* (2014).
5. Bernier, P. & Paré, D. Using ecosystem CO2 measurements to estimate the timing and magnitude of greenhouse gas mitigation potential of forest bioenergy. *GCB Bioenergy* **5,** 67–72 (2013).
6. Holtsmark, B. Harvesting in boreal forests and the biofuel carbon debt. *Climatic Change* **112,** 415–428 (2012).
7. Hudiburg, T. W., Law, B. E., Wirth, C. & Luyssaert, S. Regional carbon dioxide implications of forest bioenergy production. *Nature Clim. Change* **1,** 419–423 (2011).
8. McKechnie, J., Colombo, S., Chen, J., Mabee, W. & MacLean, H. L. Forest Bioenergy or Forest Carbon? Assessing Trade-Offs in Greenhouse Gas Mitigation with Wood-Based Fuels. *Environ. Sci. Technol.* **45,** 789–795 (2011).
9. Manomet Center for Conservation Sciences. *Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources*. (2010).
10. Zanchi, G., Pena, N. & Bird, N. Is woody bioenergy carbon neutral? A comparative assessment of emissions from consumption of woody bioenergy and fossil fuel. *Glob. Change Biol. Bioenergy* **4,** 761–772 (2012).
11. Holtsmark, B. The outcome is in the assumptions: analyzing the effects on atmospheric CO2 levels of increased use of bioenergy from forest biomass. *GCB Bioenergy* **5,** 467–473 (2013).

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12. Booth, M. S. Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy. *Environ. Res. Lett.* **13,** 035001 (2018).

13. *Commentary by the European Academies' Science Advisory Council (EASAC) on Forest Bioenergy and Carbon Neutrality*. (EASAC, 2018).

14. Timothy D. Searchinger, Tim Beringer, Daniel M. Kammen, Eric F. Lambin, Wolfgang Lucht, Peter Raven, Jean-Pascal van Ypersele. Europe's renewable energy directive poised to harm global forests. *Nature Communications* **9,** 3741 (2018).

15. Cintas, O. *et al.* Carbon balances of bioenergy systems using biomass from forests managed with long rotations: bridging the gap between stand and landscape assessments. *GCB Bioenergy* **9,** 1238–1251 (2017).

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Appendix A
To the Comments of Phil Duffy & Tim Searchinger

Page 2: Delete and replace language as follows: "~~The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to 12 account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.~~ Whatever baseline is used, it must be coupled with a modeling structure that evaluates only the incremental effects of the bioenergy use and does not credit or penalize bioenergy for exogenous factors." *Explanation: Throughout the report, there is a potential for confusion on this fundamental point. The principal error with the original EPA proposal, which was pointed out by the first full SAB report on this issue, was that it confused the incremental effects of bioenergy and exogenous factors and therefore credited bioenergy offsetting carbon gains that are due to the overall U.S. forest carbon sink which is occurring and would occur anyway.*

Insert page 2: line 32: the following:

"Assuring analysis only of incremental effect of bioenergy:

Carbon impacts of bioenergy must be based on the incremental change in carbon stocks on the land associated with a particular stationary facility. That change must not include any changes that would occur anyway, for example carbon sequestration (or losses) that would occur somewhere due to forests regrowth from harvests prior to the operation of the facility, to climate change, or to changes in harvest levels for uses other than bioenergy. Modeling must assume those "anyway" changes in the business as usual baseline. Put simply, emissions from bioenergy should be due to the biophysical effects that result from the bioenergy harvest alone and not exogenous changes." *Explanation: This language will assure that notwithstanding any other ambiguous, exogenous changes in carbon stocks are not assigned to bioenergy.*

Page 9: line 2: "It is the balance of losses and credits that determine carbon stock effects" should be changed to "It is the balance of losses and credits that result from the incremental effects of the bioenergy harvest that determine carbon stock effects."

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Page 9: line 2-10 Delete line 2 from "Moreover" to end of line 10. *Explanation: This language endorses use of economic modeling.*

Page 9: line 14: Sentence should be changed as follows: "~~We also underscore our caution that the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, policy, market forces, or natural causes~~." We also underscore our caution that the regrowth of forests harvested for bioenergy should not be assumed without appropriate guarantees that the land will be managed for tis regrowth." *Explanation: There are several problems with this language. First, it does not clearly distinguish exogenous from endogenous effects of bioenergy. In addition, once bioenergy is burned, there no way to unburn it. It is unlikely that regulators will penalize or reward a stationary installation for other changes. Therefore, the real issue is forward-focused and should insure that if regrowth is counted in a bioenergy model, regrowth is extremely likely to occur.*

Page 2, line 21: delete "economic and": Explanation: This language appears to encourage inappropriate and unjustified use of economic models to claim credits for bioenergy achieved by other people and on other lands.

Page 2: line 46. Add at the end: "The BAF and greenhouse gas consequences of different feedstocks should be separately calculated to assure that those using feedstocks with larger greenhouse gas benefits are appropriately rewarded and incentive and those who use feedstocks with higher costs or lower benefits are not." *Explanation: At the present, the draft appears to suggest that one BAF should be assigned to all forest biomass in a region. Doing so would improperly incentive feedstocks than increase emissions over relevant time periods and improperly disincentive feedstocks that reduce emissions.*

Page 10, line 1: insertion of the following two words "the difference in carbon stocks between the reference (no bioenergy counterfactual baseline) and the increased biomass . . . " *Explanation: Without this language, it is not clear exactly what the baseline is.*

Page 10: delete lines 4-8: *Explanation: The indirect effects language is vague and should be covered separately as we suggest in language above.*

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Delete page 11 from "If" in line 8 to the end. "~~If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the reference scenarios, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.~~" *Explanation: This language does not properly distinguish between exogenous changes going on in a forest and the incremental effects of the bioenergy. In addition, it suggests that simply diverting wood from other forest uses to bioenergy means the bioenergy is carbon neutral when we should instead assume it would be replaced both because that is likely to occur, because any reductions in consumption are likely to have their own carbon consequences as people use alternative goods, and because regulations focused on emissions intensity should not be based on changes in consumption due to price fluctuations.*

Cut page 11, lines 13-28. – "~~Biomass, particularly from forest sources, is also used for producing non-energy products. The demand for bioenergy can lead to a diversion of biomass from those products to energy use and lead to an immediate reduction in carbon stocks in products. It is also possible that anticipation of future demand for biomass by stationary facilities can lead to land conversion, reforestation and retention, or accumulation of carbon stocks in a growing forest. In general terms, the amount of either net loss or net gain of carbon on the landscape is influenced by changes in many factors including those influencing net primary production and removals, and the net effect can be expected to vary over time. When agricultural feedstocks that are harvested annually from land under continuous production, the time lag between harvest, CO2 emissions from conversion to energy, and regrowth on land is likely to be close to one year, and the harvested carbon will be fully regained, with no net impact on above-ground carbon stocks. The production of these feedstocks may directly affect carbon stocks below-ground by increasing or decreasing soil carbon stocks relative to the use of the land in the reference scenario. The demand for bioenergy can also affect carbon stocks by leading to a change in the use of land which could either release carbon stored in the land (for example if permanent grasslands are converted to annual agricultural production) or accumulate carbon on the land (for example through reforestation as annual cropland is converted back to forests).~~"*Explanation: This language endorses economic modeling implicitly through the "anticipation of future demand for biomass" sentence. It also includes an inadequate discussion of what you do when bioenergy diverts cropland or crops, which if addressed, should be addressed much more carefully and thoroughly.*

Comments on the SAB Panel Draft Report Regarding EPA's Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources (2014)

Submitted by: Timothy Searchinger, (Princeton University; tsearchi@princeton.edu)
William Moomaw (Tufts University, william.moomaw@tufts.edu)
Paul Scott (Toulouse School of Economics, ptscott@gmail.com)
Eduardo Souza-Rodrigues (University of Toronto, e.souzarodrigues@utoronto.ca)

We offer these comments on the draft panel report related to accounting of greenhouse gas emissions from bioenergy. We write to express concerns about this report and recommend that the full SAB initiate a process to make appropriate changes.

Introduction: This report focuses on how to count the carbon consequences of bioenergy, particularly the harvest of wood for power plants, and it is of great importance to climate change and to the world's forests. Harvesting additional trees from forests to burn for electricity will tend to increase carbon dioxide in the atmosphere for decades. At this time, however, Europe is importing large quantities of wood pellets crafted from trees harvested in the United States to burn in power plants based on an accounting error that treats all biomass as carbon neutral. Carbon neutral means that that the carbon dioxide emitted by burning biomass is not counted. European utilities that are required to reduce emissions can therefore switch from coal or gas to wood and mistakenly treat that change as a full reduction of carbon from the fuel itself.

The potential implications of miscounting bioenergy from wood for the world's forests and climate change are large because vast quantities of wood are needed to produce even modest quantities of electricity. Some modeling by the US Energy Information Agency has estimated that if biomass is treated as carbon neutral, power plants will respond to modest carbon prices by producing an additional 4% of electricity from biomass by 2035. If that biomass comes from wood, it would require roughly 70% of all existing U.S. wood harvest. Globally, supplying 3% of the world's existing primary energy demand from bioenergy would require roughly a doubling of the world's commercial tree harvest.

The SAB's bioenergy report is also important because of the likelihood that other countries would follow flawed U.S. rules. If the U.S. counts the harvest of trees as carbon free or low carbon, many other countries with extensive forests are likely to do the same either to fuel their own power plants or to export wood pellets to developed countries.

The European accounting error results from what now a well-known misapplication of national greenhouse gas reporting guidelines under the UN Framework Convention on Climate Change (Searchinger et al. 2009). Those

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guidelines do not treat bioenergy as carbon neutral. Instead, the basic principle of those guidelines is that for national accounting purposes bioenergy harvests of wood can be counted as emissions from land use change in the land use count. For example, when US forests are cut and burned in another country, the emissions are counted in the U.S. even though they mostly occur in Europe. On a global basis, therefore the emissions balance out. However, when a country has a regulatory scheme that does not apply to emissions from land use change, or if it imports wood, it must count the emissions when the biomass is burned to avoid creating a false incentive or it must count reductions in terrestrial carbon as a cost of bioenergy. This principle applies to EPA regulatory schemes such as the Clean Power Plant.

The panel report does not treat biomass as automatically carbon free but addresses two primary topics that could have the effect of badly miscalculating the carbon consequences of bioenergy. One concerns the time frame by which to judge bioenergy. Bioenergy initially increases greenhouse gas emissions, but over time, it has the potential to reduce net emissions (counting in the benefits of reduced fossil fuel consumption) if and when forest growth rebuilds carbon stocks. From a climate perspective, the value of actions that increase and then reduce emissions through bioenergy should be identical to the value of any other actions that do so (such as increasing coal use before switching eventually to solar). Although the panel report expresses inconsistent views about this timing question, some of its language would de facto treat most forest harvests for bioenergy as carbon free, and none of its treatment of timing addresses the relevant questions. Strangely there is a whole academic field focused on valuing how emissions and mitigation change over time through the "social cost of carbon," but the report ignores this field entirely even though it is actually being used by the government.

The other major problem with the report is its endorsement of analyzing impacts on forests of bioenergy demand through the use of what are necessarily highly complex and extremely uncertain economic and land use models that have never yet been validated. The report does so without analysis of whether any such models have sufficient empirical support and validation to generate reliable estimates or could plausibly develop that support in the near future. At this time, as a separate EPA-sponsored peer review of the FASOM model makes clear, models of this type rely on large numbers of assumptions, adopt large numbers of parameters that lack proper econometric support, and end up imposing decision rules with little to no empirical basis to avoid awkward-looking results. The danger is that poorly designed or manipulated models can claim without proper justification that additional demand for wood actually increases the quantity of carbon in forests – like some FASOM modeling. Such results imply not only that harvesting trees for energy is good for the climate, but also that the country's vast commitment to paper recycling is bad because it reduces demand for wood. If the U.S. embraces this kind of modeling, other countries are likely to develop models that justify extensive harvests of their forests.

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1. Short background on bioenergy accounting

Burning biomass for energy emits carbon into the environment just like burning fossil fuels, and typically emits more carbon than burning fossil fuels because of various lower efficiencies. If and when bioenergy reduces emissions, that can only occur because another process offsets these emissions. The first requirement of any offset is that it be additional. Using forest residues or waste can provide an offset. If residues would otherwise be burned in the field, the emissions of burning those wastes instead for energy are offset by the reduction of the emissions in the field. Plant growth absorbs carbon and can also provide an offset. However, only additional plant growth can serve as an offset.

Thus, the mere fact that trees grew and absorbed carbon does not make them a carbon neutral source of energy because that plant growth occurred anyway and already reduced carbon in the atmosphere. Using this biomass for bioenergy by itself cannot reduce carbon further. Similarly, the mere fact that trees would grow back does not automatically provide an offset. Tree growth can begin to offset bioenergy emissions only if and when trees regrowing after a harvest grow at faster rates than trees would grow without the harvest.

Another way of viewing the precise issue is to recognize that burning fossil fuels takes carbon otherwise stored in the ground and puts it in the air. But burning biomass also puts carbon into the air that would typically otherwise be stored in plants and soils.

A large number of papers have analyzed the consequences of harvesting trees for electricity in a wide range of forests under a wide range of forest regimes and have found that doing so increases greenhouse gas concentrations for decades. Bernier & Pare (2012); Holtsmark (2011); Hudiburg, T. et al. (2011); Mckechnie et al. (2011); Mitchell et al. (2012); Zanchi et al. (2011); Walker et al. (2010). In these studies, the assumption is that bioenergy results in additional harvest of trees. The EPA has made the same assumption when estimating the greenhouse gas consequences of paper recycling (ICF 2010). ("The net increase in forest carbon storage from recycling or source reduction is equal to the additional amount of carbon contained in wood that is not harvested as a result of increased recycling or source reduction."). This assumption of additional harvest works even if the trees harvested are from a commercial forest and would otherwise be harvested and used for wood products so long as the wood diverted to bioenergy would be replaced by additional harvesting of forests elsewhere with the same overall efficiency.

The reasons these harvests increase emissions for decades are intuitively understandable. First and most obviously, when trees are cut and burned for bioenergy, there is an immediate release of carbon stored, just like burning fossil

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fuels. Second, although the trees may grow back, the trees that were cut would also often continue to grow if not cut, and additional sequestration is lost. In fact, middle-aged forests (often harvested for wood) would typically continue to absorb more carbon dioxide than young forests for an extended period of time. During this time, the carbon debt increases. Third, there are great carbon inefficiencies in using wood. Less than two-thirds of the biomass in trees is likely to be used, leaving roots and some branches and leaves to decompose, which emit carbon without any displacement of fossil fuels. [1] Soil carbon losses add to these initial carbon releases. In the power plant itself, the lower burning temperature and greater carbon intensity of wood than both coal and natural gas lead to more carbon releases per kilowatt hour. The combined results mean far more carbon is released immediately or in a few years than would alternatively be released by burning coal.

If forests are allowed to grow back (and not all the carbon dioxide is necessarily reabsorbed), this regrowth will generally require decades before carbon stocks near the carbon stocks the forests would otherwise contain. During the interim, carbon in the atmosphere is higher than using fossil fuels. This timing pattern is why timing considerations are so important. There are parts of the panel report that argue that the only result policymakers should focus on is the carbon in the atmosphere after 100 years. With such a focus, so long as forest regrowth might result in net reductions in carbon after 100 years, users of bioenergy should be credited as though it had in fact reduced emissions in the initial year. There would therefore be no consequences to increasing emissions for decades and no discounting of reductions that would only occur after 100 years.

2. Timing

2A. Valuing emissions and mitigation over time

The issue of timing is basically as follows. Governments are imposing requirements to reduce emissions in specific years, such as requirements in the Clean Power Plan for utilities to reduce emissions. That requirement typically means reducing emissions up the smokestack that year, for example, by switching to solar or wind or gas rather than coal. Much bioenergy would increase emissions for decades but potentially reduce emissions in later years if forests regrow. The question is how policy should value such a measure that starts by increasing emissions even for decades compared to another action that actually reduces emissions in the first year.

The question of how to value emissions and mitigation is the same issue for bioenergy and for climate policy in general. For example, if the government credits a power plant switching to biomass with immediate reductions based on expected results after 100 years, the government should similarly credit a power plant's

1 For example, Wang et. al. 2011 estimated that 32% of all carbon in loblolly pine forests is contained in

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proposal to increase emissions for decades by using more coal so long as it provides equivalently enforceable promises to reduce emissions by year 100.

In addition, if the only focus of policy is increased radiative forcing after 100 years, efforts to mitigate methane emissions today would be essentially meaningless as almost no methane emitted today would remain after 100 years. Federal and international governments have large programs to reduce methane emissions. With almost no discussion, the implications of some portions of the panel report are that these efforts should be abandoned.

There is, not surprisingly, a very large literature dealing with the significance of timing of emissions and their mitigation. Much of this literature is expressed through estimates of the "social cost of carbon," which represents the cost of emissions and value of mitigation, and how it changes over time. (According to google scholar, there are 218 papers with the "social cost of carbon" in the title alone, and 4,820 somewhere in the text.) The federal government already uses social cost of carbon for regulatory purposes (EPA, The Social Cost of Carbon, https://www3.epa.gov/climatechange/EPAactivities/economics/scc.html), and as discussed below, its formula discounts future emissions reductions when expressed in today's dollars There are many factors that determine this SCC, and plausible reasons, grounded in scientific estimates of thresholds and many uncertainties to adjust present calculations so as to provide yet greater value to earlier mitigation. A striking feature of the panel report is that it ignores this literature.

Neither does the panel recognize that its recommendations are inconsistent with the way the United States reports bioenergy emissions under the UN Framework Convention on Climate Change or discuss the implications. These rules require that biogenic emissions be reported as emissions from land use change, which includes harvest of trees, in the year in which they occur, but if that is not done, they must be reported when burned. To be consistent, either the EPA must count the emissions from smokestacks or count the emissions from tree removal when they occur.

2B. *The panel recommendations*.

The panel report provides inconsistent and mutually exclusive approaches to addressing emission and removal timing.

2B1. Report language encouraging focus only on the effect on radiative forcing after 100 years.

The panel report contains a few pages arguing, in effect, that the proper focus for evaluating any trajectory of emissions and mitigation is the net emissions after 100 years. Under this approach, if bioenergy increases emissions for decades by 100 tons or even more, but reduces emissions by 100 tons in the year 100, it should be treated analogously with a measure that reduces emissions by 100 tons in year one.

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The rationale is that newer climate models estimate that peak atmospheric temperatures are a function of cumulative carbon emissions. Reductions at any time within 100 years would therefore equivalently reduce peak emissions after 100 years.

This reasoning is inconsistent with a broad literature, often expressed in technical terms, but which we explain more simply.

- Even if peak temperatures and damages are the same after 100 years, earlier emissions cause damages in the first 100 years. During the entire regrowth period, there is additional carbon dioxide in the atmosphere trapping heat, melting glaciers, raising sea levels, adding to ocean acidity. Unless these are assigned no value, earlier mitigation must therefore have higher value than later mitigation.

- Even if subsequent sequestration reabsorbs this carbon, damages from the first decades of additional warming do not suddenly disappear. The physical consequences of earlier warming for oceans, permafrost and forests will continue. Any weakened economic growth from the earlier damages will also reduce long-term economic growth.

- The level of emissions matters, not merely the pattern, particularly with regard to damage thresholds. It is likely that damages do not always increase gradually with temperature but instead exhibit thresholds that cause more rapid increases in damages. Once specific but uncertain levels of cumulative warming are reached, consequences may follow that cannot be fully offset by subsequent emissions reductions. The risk of crossing these uncertain levels implies substantially higher value for earlier rather than later emissions. This value can be expressed in part as the estimated value of avoiding this risk. There is also an option value based on the increased flexibility that early reductions provide to adopt more urgent mitigation pathways if increasing evidence shows the need for it.

- One rational approach to this concern is to establish a fixed target for warming, such as 2°C, which translates into a fixed cap on anthropogenic emissions. (Typical cumulative emissions estimates for this target are on the order of 1,000 gigatons from 2000 to 2050. [Meinshausen et al. 2009]). At this time, societies appear to be on a trajectory to exceed this cap before 2050. If this target represents a belief that 2°C may represent a significant damage threshold, then emissions reductions that happen in time to help avoid this threshold have more value than emissions reductions that happen subsequently. Bioenergy activity that actually increases emissions by 2050 could have negative value by this measure regardless of future reductions.

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- Beyond damages, many general economic principles come into play. One is the time value of money. It reflects the value of present consumption and the expectation that future societies will be wealthier. (That growth will occur unless climate change in the interim has such severe effects that it undermines economic growth, which would be yet another reason to favor earlier mitigation.) These economic factors increase the value of mitigation today relative to future mitigation.

All of this thinking, expressed in various forms in the literature, contradicts the reasoning of the panel report and is unaddressed.

To support its reasoning, the panel report also cites papers by Kirschbaum (2003) and Cherubini (2012), which take different paths to argue for some benefits for bioenergy. Among other problems, the panel appears unaware that both the Kirschbaum and Cherubini papers use pulse-emission models that contradict the cumulative emissions model of future warming because the pulse-emissions model do not account for climate/carbon cycle feedbacks (Joos et al. 2013; National Research Council 2016). The pulse-emission models assume that emissions today actually cause less warming, for example, 50 years from now than emissions 50 years from now because oceans and forests would take up much of the carbon released today by that future year. In that way, these pulse-emission models by themselves suggest a value to delaying mitigation. But if the "cumulative emissions" models are correct – and the panel correctly argues that they are better science – then emissions in year one have the same warming effect in year 50 and also cause warming in the interim, so the basis of these other papers is wrong.

2B2. Timing approaches based on harvest cycles.

Patterns of forest removal and growth: Notwithstanding the "100-year" language above, the report's basic approach to timing is quite different. It is based on patterns of wood removal and regrowth in (mostly) managed forests that are harvested in part for the same quantity of bioenergy consistently for decades using the same management regime. Eventually, as earlier tracts regrow, the potential exists to reach an equilibrium in which the loss of carbon from harvesting each new tract is balanced by the carbon gained from the regrowth of the earlier tracts. (This equilibrium does not mean that carbon stocks are unchanged from before bioenergy management, only that there is no further change.) The panel recommends that this time period, which could be decades serve as the time period within which to judge bioenergy. In scenario 1 of Appendix D, for example, this equilibrium period occurs at 90 years. The panel argues that this period is the relevant "policy horizon." Having done that, the panel then provides three different ways of valuing this pattern.

The basic problem with all of these approaches is that the panel is confusing two separate questions. The panel approach describes how much carbon will be physically added to the air and when (under specific assumptions about which forests

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are harvested for bioenergy, how they are harvested, and how long). But the timing question is the entirely separate question of how we value these different amounts of carbon at different times. That question depends on the impacts on climate, climate damages, economic factors that influence the value of money across time, risks, and the differential costs of the mitigation.

Valuing carbon within forest cycles: Having established a timeline, the panel report does go on to identify three separate ways of evaluating emissions within that timeline, and these approaches at least do bear on timing considerations.

- One approach might be to care only about the effect of bioenergy use on carbon in the last year. This approach ignores all the prior impacts on climate. The problem with this approach is that for no articulated reason, it ignores all the damages that occur within the first 90 years, and all of the other factors that bear on timing.
- Another approach would be, in effect, to judge bioenergy by the average net carbon removed relative to the gross carbon removed from the forest over the period (e.g. 90 years). The problem with this approach is that it does not value earlier emissions higher than later emissions in contrast to the many reasons to do so.
- To the credit of the panel report, the third approach, the integrative approach, is the principal recommendation, and it is better. This approach starts by counting all the additional net "carbon years," in which the total amount of carbon removed from the forest in each year is summed. The ratio of these net carbon years to the gross carbon years would be the amount used.

This third approach is in effect a form of time discounting. It recognizes, in effect, that the additional carbon in the atmosphere each year has a cost, and it compares this net cost (recognizing forest regrowth) relative to the total cost without any forest regrowth. These are important factors in a proper timing consideration.

Despite this fact, the overall report retains several problems. First, there is no explanation of why this recommended approach is appropriate, and it is of course contradicted by the limited explanation of timing consideration that is in the report. The report should include a proper consideration of timing questions in which these issues are one factor. Second, although the timing valuation has some merit, there is no particular reason to tie it to the period chosen based on harvest regime.

There are also large practical problems. The whole timing approach recommended requires judging bioenergy harvests in year one based on an assumption that those harvests will continue for bioenergy in the same manner, and in the same amount over the 90 year period (or other period to equilibrium). There is no reason to believe that will occur. For many uses, bioenergy (even based on flawed

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carbon assumptions) would only be an interim strategy, such as co-firing coal until the plant retires. There is also no particular reason to believe that biomass would be supplied from the same forest, using the same harvest regime, for this whole period. The approach therefore requires a series of fictional assumptions about the course of actions for decades to judge any bioenergy.

2C. Potentially rational approaches to timing

Here we describe some of the potentially plausible approaches to timing considerations that might be consistent with economic theory.

- Government SCC: Since 2010, the U.S. government has used estimates of the social cost of carbon as a shadow price of carbon in regulatory impact analyses under Executive Order 13563. These social cost of carbon estimates, which have been previously employed by EPA in numerous applications including the Clean Power Plan, are based on economic analysis using a set of climate change integrated assessment models. Interagency guidance mandates the use of four time series of the social cost of carbon, which are associated with three different consumption discount rates. The four time series reflect the mean estimates of the social cost at a 5%, 3% and 2.5% annual consumption discount rate, and the 95th percentile at a 3% consumption discount rate. Over 2020–2030, the average annual growth rates of these time series (based on the May 2015 Technical Support Document) are 3.4%, 2.1%, 1.7%, and 2.3%, respectively, and this growth slows in subsequent decades. Thus, were bioenergy to be valued in a manner consistent with broader U.S. government regulatory policy, the carbon discount rate would be between 0.7% and 1.6% annually between 2020 and 2030, and increase in subsequent decades. Applying the U.S. government estimates as best we can to the hypothetical emissions profile in case study one in Appendix D, we estimate that the BAF would be between 0.25 and 0.32. (These figures are actually comparable to the integrated BAF recommended by the panel although that might not be true for other scenarios, and this approach is based on a clear economic rationale.)

- Adjusted SCC: There are many considerations not emphasized in the U.S. government social cost of carbon analysis that would increase the difference between earlier and later emissions by altering the rate of growth in the SCC. For example, Cai et al. (2015) show that the potential for 'tipping points' in the climate system lends an added 'insurance' value to emissions reductions that occur before tipping points are crossed. This added early value increases the carbon discount rate. An even more recent paper found that when factoring in the ways in which crossing some tipping points increases the risk of others, the optimal climate strategy

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required elimination of emissions by 2050, which would therefore dramatically increase the costs of actions that increase emissions within that time-frame (Cai et al. 2016). A related, although not identical value, would be the option value to be able to respond to information about harsh effects with additional mitigation, a value undermined by efforts that actually increase carbon in initial years.

The international goal of limiting warming to below 2°C and as close as possible to 1.5°C also implies a far higher value of emissions reductions that occur before this target is breached. It too implies high costs from bioenergy activities that increase emissions in this time. It is hard to see how bioenergy uses that actually increase carbon in the atmosphere by 2030 and 2050 are consistent with U.S. commitments to reduce emissions by these dates. Early emissions reductions therefore have the value of supporting U.S. leadership and promoting international reciprocity.

- Counting emissions and offsets when they occur: All policies that assign lifetime values in advance to bioenergy projects shift risk in a variety of ways from those undertaking the project to society at large. An alternative, straightforward approach that would avoid this shifting of risk would be to count emissions and reductions when they occur (e.g., Melilio et al., 2009). This is precisely the approach implicit in either a carbon tax or a "cap and trade" system. Any regulated entity required to reduce emissions can still increase emissions and buy credits from some other source and then provide its own emissions reductions or even sell credits in the future. Any entity facing a tax can still increase emissions in year one and pay the tax and reap the benefit of paying a smaller tax later when emissions decline. The fact that any such entity would likely apply a meaningful discount rate to this approach, which in effect values emissions reductions earlier more than later, is just one way of understanding why earlier emissions reductions should generally be viewed as more valuable than later reductions.

  This approach would also assure that carbon accounting practiced by the EPA is consistent with the way the U.S. reports emissions under the UN Framework Convention on Climate Change, which requires that forest carbon stock reductions due to bioenergy be counted in the year they occur.

3. Panel's Endorsement of economic models

The other major issue raised by the panel report is its endorsement of the use of economic models to analyze the carbon implications of removing forest biomass. There certainly are economic effects in increased demand for forest biomass – and they could either increase or decrease the carbon impacts – but the initial question is

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whether economic models are capable at this time of capturing these effects with sufficient reliability. A primary focus of the SAB on many environmental issues is the reliability of different kinds of environmental evidence. The SAB panel report includes no discussion of the reliability or potential of these models. At this time, potential models yield widely different results, and can be easily programmed to yield a huge span of results. Unless and until they are shown to be reliable, the SAB should not endorse them.

This analysis is of enormous potential significance. For example, one of the modeling analyses in the draft EPA framework sent to the SAB found that every ton of carbon removed from a southeastern forest for bioenergy resulted in an increase in forest carbon of 1.4 tons. If this analysis were true, not only would forest biomass be better than carbon-free, but paper and cardboard recycling programs in the United States that depress forest product demand would be harmful to the climate. (Both bioenergy demand and paper demand primarily use pulpwood quality wood.) Yet, the EPA itself has encouraged this recycling using its "WARM" model, which assumes that a ton of carbon in reduced pulpwood demand results in a saved ton of forest carbon (ICF 2010).

3A. Nature of economic consequences

The models tend to focus on increased demand in a region, such as the Southeast and analyze potential economic responses to the increase in prices. Because wood and the land that produce it are assets however used, each of these responses of increasing demand for wood also has carbon costs. For the economic model to be reliable, both those responses and their costs must be estimated reliably.

- Increased cutting in target region: The most obvious response is that there is an increase in cutting of existing forests. In this case, the carbon cost lies in the loss of carbon stored in the forest.

- Increased cutting in other regions: A second possible response is a diversion of existing wood harvests to bioenergy from other uses such as pulp & paper, resulting in a replacement through additional harvest of existing trees either in other regions or abroad. The carbon cost is the loss of carbon storage in these other forests.

- Reduction in wood consumption and possible increase use of other materials: A third possible response is that people consume fewer wood products, such as less cardboard packaging or paperboard products. The carbon cost would be the greenhouse gas released if some or most of that reduced consumption were replaced by plastics or other materials, and if some sawn timber is diverted, possibly concrete.

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- Increased planting or management: A fourth possible response is that landowners plant more forests or intensify their management of existing forests. However, this response is also not cost free. Land planted to forest will typically alternatively be in some kind of agricultural use. Replacing the food will likely require converting some non-agricultural land to agricultural use elsewhere, and possibly shift some livestock production abroad.

The first response is the response analyzed by purely biophysical models of tree harvest and regrowth. There is no inherent reason to believe that the other responses would have lower carbon consequences. The net consequences of each effect depend primarily on relative "carbon efficiencies." If wood harvested abroad or in other regions is harvested less efficiently than wood harvested in the Southeast, then replacing wood elsewhere will have higher carbon costs. If other packaging or construction material is more carbon intensive than wood products, reductions in wood consumption could lead to more total emissions. If replacing crops or livestock occurs abroad, where it is generally less land and greenhouse gas efficient than in the U.S. (Johnson et al. 2014; Herrero et al. 2013), planting forests on agricultural land in the U.S. could also lead to higher total greenhouse gases in the atmosphere.

One reason some models or papers have found carbon benefits from these economic consequences is that they ignore some of these carbon costs. For example, in the FASOM described above, the modeling assumed no carbon cost in replacing Southeastern wood diverted to bioenergy from other uses, nor of replacing agricultural products. Similarly, one modeling analysis by a member of the panel estimated that nearly all bioenergy wood in the U.S. would be supplied by diversions from other uses of pulpwood, but did not count any of the costs of replacing that wood or its uses (Sedjo 2013).

3B. Reliability of these economic models

In part because of the need to count all costs, the panel report recommends that any model used be appropriately comprehensive and global, and focus on both forestry and agricultural effects. But doing so dramatically increases the complexity of the model and multiplies the consequences of the various uncertainties. (Some modelers at some times suggested they can adopt a simply derived "leakage" factor, but there is no way of deriving a leakage factor simply.) For any analytical tool, the burden should be on that tool to demonstrate its reliability.

There are many reasons for large doubts in this context

- Wide modeling differences: Global land use and agricultural models today generate a very broad range of different results (Robinson et al. 2014; Nelson et al. 2014). Which model therefore should be used and why? Even

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among members of the panel, papers addressing bioenergy from forest biomass have widely different estimates regarding how much will derive from diversions of wood and how much from additional production. Galik & Abt (2015); Sedjo et al. (2011); Wang et al. (2015).

- Enormous complexity: The demand and supply interactions that these models in some form attempt to estimate are very high in number and complexity. When a new source of demand occurs for wood or agricultural land, these models attempt to estimate how much prices will prices, how much would these prices result in reductions in pure consumption, how much in switches in consumption and to which products, how much in changes in forestry or agricultural management practices, how much in changes in land use, and where and how. For example, if grazing land is diverted in the US to trees, questions include how much milk and meat would be replaced, where in the world that would occur, how much would be produced with what land, and with what greenhouse gas efficiencies. These estimates require a very large range of uncertain and difficult to derive parameters. Models necessarily try to simplify these interactions to limit the parameters, but the simplifications are not necessarily accurate. Even the purely biophysical uncertainties are daunting. For example, there is no good data on the efficiencies with which wood is harvested in different parts of the world.

- Opaqueness: For at least most of these models, there is little clear documentation on where and how underlying parameters were derived. Even when EPA had a peer review team analyze FASOM, it indicated an inability to analyze most parameters and functions because of lack of clear documentation (as discussed more below).

- Insufficient econometric foundations: Nearly all the models require parameters that have never been econometrically estimated, and which are therefore assumed or are borrowed from other parameters out of necessity rather than because of a clear rationale. A yield response for cassava in Africa may be based on some estimate of corn yield response in the U.S. Of the parameters that are estimated, many are not based on proper econometric methods. In general, de facto cross-price elasticities of demand and supply, which determine how changes in demand or supply of one product influence another, are not empirically estimated but are instead generated through an assumed functional form.

- Dependence on uncertain future demand: Some models predicate forestry decisions on the assumption that bioenergy demand today will also guarantee equivalent bioenergy demand in the future, inducing farmers to plant more trees today. Even apart from climate accounting, bioenergy

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demand in the future would depend on a range of unknown cost developments. In many countries, bioenergy is viewed only as a transition strategy. Projections of future bioenergy demand (and landowner assumptions about those demands) introduce yet another important uncertainty in those models.

- Potential impacts outside experience range: If treated as a low carbon source of energy, demand for wood for bioenergy could lead to short-term increases in demand greater than the entire existing U.S. wood demand, and therefore outside historical ranges of experience that might be used to make proper economic estimates.

- Lack of validation: Perhaps most importantly, there is a lack of empirical validation of these models. The panel report calls for some kind of retroactive validation, but the panel does not identify any models for which this has been satisfactorily done. At a minimum, for this kind of model, the validation must be done using data independent of the data used to "tune" the model. Validation must also avoid false claims. Some models build a great deal of results from historical data directly into them, and then claim victory if the model's own features do not greatly distort those preset data.

Before a model should actually be used, all important parameters and functions should be derived using proper, and clearly documented econometric methods. There should also be a solid validation. Until there is demonstration of a viable model under these criteria, and why that model is to be trusted rather than another, the SAB should not be recommending use of such model to EPA.

3C. Experiences with the EPA FASOM Model

An EPA peer review of the FASOM model reveals the difficulties in trying to assure that the model is actually reliable (Segerson et al. 2011). The peer review found:

- The model "presents a false sense of precision."
- Many of the model outcomes "are driven by assumptions about future productivity growth" that the review panel found "highly questionable" as well as "assumptions about agricultural land" demand that "are highly suspect."
- The model generates "large fluctuations in outcomes from one 5-year period to the next" that cannot be adequately explained.

Yet these and many other detailed criticisms are less significant than several other features of the peer review.

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- One, the panel found that the underlying structure of the model – the portions that are supposed to be based on empirical evidence – do not predict plausible results. As a result, the modelers impose "constraints designed to produce 'reasonable' projections by, for example, restricting regional crop mix or livestock mix," and without these constraints, the model will "yield 'unreasonable' predictions." Even with these correction rules, "A number of the model's predictions do not seem consistent with expectations." This problem casts serious doubts on the reliability of such a model unless it can be independently and rigorously validated against real data experience. It means that the modelers are imposing constraints specifically for the purpose of making the model results appear reasonable, not that any empirically grounded features of the model are themselves generating reasonable results.

- Two, although the peer review report is strongly critical about many model features that the panelists could review, the review panel could not actually review the majority of actual parameters in the model because of a lack of model documentation. "To judge the credibility of the model's results and have confidence in them, one must be able to see and understand fully the model's structure and inputs. The documentation that was provided to the review panel did not allow the panel to gain such an understanding. It provided general information about model structure and some details about model inputs and parameter values. However, much of the documentation provided simply alludes to general data sources from which information was drawn . . . rather than providing specific estimates (for example, of actual or implied elasticities) that can be judged based on other information."

- Three, what documentation was provided made clear, "in cases where data are not available, parameter values are assumed (see, for example, p. 6-7), presumably based on expert opinion, although the basis for these assumptions/opinions is not documented." Where a model is based on several "assumptions/opinions," it cannot be viewed as being independently reliable absent some other basis for establishing reliability.

Finally, the review made clear that the model has never been "validated against historical data," let alone with future predictions. This point is fundamental. Proper validation is hard and must be done carefully. Once a model is "calibrated" with actual data, or programmed to fit actual annual data, the fact that its results do not differ substantially from that data is not an indication of its validity. And if a model is calibrated for one year, the fact that its results the next year are not far off provides little if any evidence of reliability. Proper validation must be done using data that is not part of the underlying original model calibration, and in ways that validate the truly predictive parts of the model and not those that are inherently "built in."

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Even with these challenges, the FASOM model applies only to the United States. If, for example, pulpwood in the United States is diverted from paper uses to bioenergy, or additional agricultural lands are planted to trees in the U.S., such changes do not imply carbon gains because much of the wood and agricultural products are likely to be replaced abroad. The challenges in predicting U.S. responses compound in predicting global responses.

3D. Significance of these limitations

Limitations of the FASOM model are important because that is the model that EPA has in fact been using to develop its bioenergy accounting framework, but even more important is the inherent nature of the problem. FASOM is not necessarily lacking because of mistakes by its authors but rather because this kind of model requires estimations of very large numbers of very complex relationships that (a) lack good underlying econometric estimation, (b) have inevitable uncertainties even when well econometrically estimated, which multiply the resulting uncertainty in the model greatly when combined with so many other factors. In practice, modelers trying to put together models of this complexity must rely on "assumptions" and unsupported extrapolation from what underlying econometric analyses are available because they cannot otherwise complete their model.

The rationale for using this type of model is that the economic feedbacks may show benefits from forest use for bioenergy not evident in assuming that additional demand for wood will require additional forest harvests. Yet, this point lacks any empirical demonstration using simpler economic analyses that look backward at the impacts of previous changes in wood demand. Unless and until there is convincing economic evidence of such effects in the past, there is no reason to pursue these other forward projecting models.

In fact, there is no physical reason that increased wood demand requires new forest plantings. Forest area within the United States has been remarkably constant over the last several decades. And both within the United States and globally, forests are accumulating large quantities of biomass as part of a forest carbon sink that plays a vital role in holding down climate change (in large part because of fertilization by nitrogen and higher levels of carbon dioxide). Although this growth does not make additional forest harvest for bioenergy carbon free – because such harvests would reduce this carbon sink -- this growth of forest biomass does make it possible for total U.S. or global timber harvests to increase several fold without reducing wood availability.[2] In turn, this growth casts doubt on whether economic forces would push additional forest plantings.

[2] For example, Pan (2011) estimates a net global forest sink of roughly 1 gigaton of carbon, roughly equal to around 2 billion tonnes of dry biomass. From 2008-2009, annual roundwood harvest according to FAOSTAT in oven dry tonnes was 1.65 billion tonnes. These figures imply that wood harvest could more than double without reducing forest carbon stocks. In the U.S., Heath et al. (2011) estimate a net forest

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These issues do not mean that economics can have nothing to say in the future about bioenergy. More rigorous, but simpler econometric studies may provide useful and reliable lessons that could help shape policy toward bioenergy in the future. Nor does it mean that global modeling studies, particularly in comparison, may not yield interesting insights about the possible interactions. But without careful evaluation and demonstration that any model of this kind today generates empirically verifiable and reliable results, the SAB should not endorse such an approach.

4. Alternatives

Any accounting system should follow the actual carbon cycle as close as possible to accurately address the climate consequences (while a full analysis should also address other environmental consequences). We cannot here outline such a system in detail. However, a more straightforward approach in general would be to count all the emissions as they are emitted up the smokestack of a power plant. Following the same principles of forest offsets, bioenergy users that are able to directly demonstrate (through efforts of their own or of their suppliers) land management changes to increase carbon stocks beyond what would otherwise occur could then be allowed to count those increases as offsets. Issues regarding such offsets would remain regarding potential displacement of food or timber for some scenarios. Yet, overall such a system would give credits in the years in which they occur, and would avoid assigning credit for carbon accumulation that has merely been predicted by a dubious economic model.

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carbon sink of roughly 300 million tons of carbon, roughly 600 million tons of biomass, which is roughly four-times U.S. annual roundwood harvest of 150 million tons.

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References

Bernier, P., Pare D. 2013. Using ecosystem CO2 measurements to estimate the timing and magnitude of greenhouse gas mitigation potential of forest bioenergy, Global Change Biology Bioenergy 5:67-72

Cai Y. et al. 2015. Environmental tipping points significantly affect the cost-benefit assessment of climate policies, PNAS 112:4606-4611

Cai Y, Lenton, T.M., Lontzek T.S. 2016. Risk of multiple interacting tipping points should encourage rapid CO2 emission reduction, Nature Climate Change

Cherubini F., Guest G., Stromman A. 2012. Application of probability distributions to the modeling of biogenic CO2 fluxes in lifecycle assessment. Glob. Ch. Bio Bioenergy 1-15

Energy Information Agency, Spreadsheet – AEO2014RenewableEnergyTable-3 cases compared (provided 2014)

Galik C., R. Abt, 2015. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in Southeastern United States, GCB Bioenergy. doi:10.1111/gcbb.12273

Heath L. et al., 2011. Carbon stocks on forestland of the United States with emphasis on USDA Forest Service ownership, Ecosphere Vol. 2, Article 6.

Herrero M. et al., 2013. Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems, PNAS 110:2088-20892

Holtsmark B (2011) Harvesting in boreal forests and the biofuel carbon dept. Climatic Change, DOI: 10.1007/s10584-011-0222-6;

Hudiburg, T. et al. 2011. Regional carbon dioxide implications of forest Bioenergy production, Nature Climate Change 1:419-423;

ICF. 2010. Forest carbon sequestration in EPA's waste reduction model

Johnson J. et al. 2014. Global agriculture and carbon trade-offs, PNAS 111:12342-12347

Joos F. et al. 2013. Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics: a multi-model analysis, Atmos. Chem. Phys., 13:2793–2825

Kirschbaum, M.U.F. 2003. Can trees buy time: An assessment of the role of vegetation sinks as part of the global carbon cycle, Climatic Change 58:47-71

Mckechnie J, Colombo S, Chen J, Mabee W, Maclean H. 2011. Forest bioenergy or

ED_004741_00009101-00032

forest carbon? Assessing trade-offs in greenhouse gas mitigation with wood-based fuels. Environmental Science & Technology 45:789-79

Meinshausen M. et al. 2009. Greenhouse-gas emission targets for limiting global warming to 2 C, Nature 458:1158-1162

Mitchell, S., Harmon, M., K. O'Connell (2012), Carbon debt and carbon sequestration parity in forest bioenergy production, Global Change Biology, Bioenergy 4:818-827

National Research Council. 2016. Assessment of approaches for updating the social cost of carbon: Phase 1 report on near-term update (National Academy of Sciences, Washington, DC)

Nelson G. et al. 2014. Climate change effects on agriculture: Economic responses to biophysical shocks, PNAS 111:3274-3279

Pan Y et al. 2011. A large and persistent climate sink in the world's forests, Science 333:988-993 (2011)

Robinson, S. et al. 2014. Comparing supply side specifications in models of global agriculture and the food system, Agricultural Economics 45:1-15

Searchinger, T. et al. 2009. Fixing a critical climate accounting error, Science 326:527-528

Segerson K. et al. 2011. Final report: Peer review of the forestry and agricultural sector optimization model with greenhouse gases (FASOM-GHG) for climate change analysis (https://www3.epa.gov/climatechange/EPAactivities/economics/modeling/peerreview_FASOM.html)

Sedjo R., B. Sohngren, A. Riddle. 2013. Wood bioenergy and land use: A challenge to the Searchinger hypothesis (Resources for the Future, Washington DC)

Walker T. et al.2010. Biomass sustainability and carbon policy study. Manomet Center for Conservation Sciences, Brunswick Maine

Wang G., D. Lear, H. Hu, P. Kapeluck. 2011. Accounting carbon storage in decaying root systems of harvested forests, Ambio 41:284-291.

Wang W., P. Dwivedi, R. Abt, M. Khanna, 2015. Carbon savings with transatlantic trade in pellets: accounting for market-driven effects Environ. Res. Lett. 10:114019

Zanchi G.A. et al. 2011. Is woody biomass carbon neutral? A comparative assessment of emissions from consumption of woody bioenergy and fossil fuel. Global Ch. Biol. DOI doi: 10.1111/j.1757-1707.2011.01149.x

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Enviva, LP
7200 Wisconsin Avenue
Suite 1000
Bethesda, MD 20814 USA

+1 (301) 657 5560
fax (301) 657 5567

www.envivabiomass.com

DATE: September 19, 2018

TO: Thomas Carpenter, DFO, United States Environmental Protection Agency (sent via email to carpenter.thomas@epa.gov)

FROM: Jennifer Jenkins, Ph.D.
Vice President and Chief Sustainability Officer, Enviva

SUBJECT: Comments on the August 29, 2018 draft report for quality review from the EPA Science Advisory Board (SAB) on the SAB's review of the 2014 draft *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*

Dear. Mr. Carpenter:

Thank you for the opportunity to provide comments on the August 29, 2018 draft report for quality review from the EPA Science Advisory Board (SAB) on the SAB's review of the 2014 draft *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*.

Enviva Holdings, LP is the world's largest producer of wood pellets, a renewable and sustainable energy source used to generate electricity and heat. Through its subsidiaries, Enviva Holdings, LP owns and operates wood pellet processing plants and deep-water export terminals in the Southeastern United States. While we produce our pellets using wood from the Southeast US, we export our product primarily to power plants and CHP facilities in the United Kingdom and Europe, where our customers typically use them to replace coal.

We believe that climate change is one of the biggest problems that we face as a society today, and we understand that the transition to a renewable energy economy is absolutely critical to the future of the planet. While its contribution today is small, policymakers around the world have concluded that a transition toward biomass and away from coal – given its ability to solve short-term intermittency, to utilize existing infrastructure, and to handle thermal loads – must be a key part of our transition away from fossil fuels.

Government policies are important for driving decarbonization in the energy sector; equally important is the growing corporate commitment to and demand for clean energy. Both public policy and corporate best practices for consuming and tracking renewable energy use require an accepted and workable carbon accounting solution for forest biomass energy. We do not think that a legitimate rule is to simply say that "all forest biomass is carbon neutral." At the same time, however, a carbon accounting solution

must be scientifically sound and based on the carbon benefits provided by sustainable forestry, *and* it must provide a workable and predictable basis upon which a potential user can make the investments necessary to convert from fossil fuel, knowing that a reliable supply of appropriate biomass will be available to fulfill that transition.

In the best interests of the climate, our goal for forest biomass should be to craft an accounting approach that: 1) discourages the conversion of forests to non-forest uses; 2) provides incentives for the growth – and not depletion – of forests; *and* 3) encourages the conversion away from fossil fuels. Together with my colleague Roger Ballentine, we laid out a framework for such an approach in our May 2018 paper (attached), entitled "A Climate Solution We Cannot Afford to Ignore: Biomass Sourced from Privately Managed Working Forests." https://www.energycentral.com/c/ec/climate-solution-we-cannot-afford-ignore-biomass-sourced-naturally-managed

We agree with the SAB's conclusion that an approach based on carbon stocks is appropriate for this purpose, and that such an analysis must be conducted on a landscape/regional basis and not at the stand level. We are pleased to see that the SAB has strongly questioned the utility of a modeling approach for this policymaking application. The market needs rules by which a consumer of forest biomass can prospectively identify adequate supply that will meet the zero carbon energy objectives that a growing number of energy consumers demand. Modeling approaches, and approaches that rely on a retroactive evaluation of the carbon value of each harvest of biomass, will not meet these needs. In particular, it is not practical or necessary to estimate some future scenario when evaluating stack emissions; instead, as we explain in our paper we can look at the landscape "balance" at the time of harvest.

There are important issues that remain unresolved, of course, and until these details are finalized we cannot endorse all of the SAB's recommendations. These outstanding issues can and should be resolved by stakeholders working together in order to enable a working market for forest biomass that will allow for fossil fuel substitution with net-zero carbon fuel while also incentivizing net forest growth.

We appreciate the SAB's work in moving this important dialogue forward, and we welcome the opportunity to contribute meaningfully and collaboratively to the regulatory development process that will undoubtedly follow.

Respectfully submitted,

Jennifer Jenkins, PhD
Vice President and Chief Sustainability Officer
Enviva
7200 Wisconsin Ave Suite 1000
Bethesda, MD 20814
jennifer.jenkins@envivabiomass.com
240-482-3828 (direct)

http://www.theenergycollective.com/rogerballentine/2433941/a-climate-solution-we-cannot-afford-to-ignore-biomass-sourced-from-naturally-managed-working-forests

A Climate Solution We Cannot Afford to Ignore: Biomass Sourced From Naturally Managed Working Forests

May 23, 2018 by Roger Ballentine Leave a Comment

By Roger Ballentine and Jennifer Jenkins.

Outside the realm of climate change deniers, there is broad consensus that we need rapid and deep decarbonization of modern energy systems to have any chance of stabilizing global average temperature rise in the neighborhood of two degrees Celsius, the threshold widely viewed as critical for avoiding the most dangerous impacts of climate change.

However, the window of opportunity for achieving the emissions reductions needed to meet this target is narrowing quickly in the face of stubborn political and economic headwinds. We can't afford to wait: we need immediate emissions reductions, and we need them urgently.

Given these narrowing odds and the enormity of the climate crisis, any suggestion that we remove a potential low-carbon energy source or technology from our climate change mitigation toolkit bears a very high burden of proof.

This climate imperative has lessened the opposition from some environmentalists to certain energy options like nuclear power, carbon capture and sequestration, and hydropower. Forest biomass, however, is still subject to withering criticism by some in the environmental community, as well as by otherwise well-meaning commentators. The media firestorm over EPA Administrator Pruitt's recent announcement that the Agency plans to treat emissions from forest biomass energy as carbon neutral certainly has not helped elevate the debate.[3]

But categorically discounting the climate change mitigation offered by forest biomass could make the mission of rapid and deep decarbonization more difficult to achieve. Biomass can directly displace fossil fuels for energy production, and when harvested from certain forest landscapes we can – and should – treat that energy as a zero-carbon resource.

First, let's limit the scope of the discussion. We describe a framework appropriate for evaluating the climate impacts of a critical subset of forest biomass — bioenergy feedstocks harvested from privately owned "working" forests, such as are prevalent in the southeastern United States – based on net changes in carbon stocks on the lands from which the biomass is harvested.

With this focus, we need not debate clearly "bad" biomass (*e.g.*, biomass harvested from otherwise untouched or conservation forests) or clearly "good" biomass (*e.g.*, wood wastes or residues from commercial forestry operations that would otherwise be burned or left to decompose on site) – we should not use the former and there is not enough of the latter to make a meaningful difference.

We are also not addressing here the very important concerns about how forest product harvesting can impact important issues like biodiversity, water quality, or habitat value. These concerns are not germane to determining the ultimate climate impact of bioenergy but can – and should – be addressed by separate sustainability guidelines and best practices.

Energy from biomass harvested from managed working forest landscapes where growth outpaces harvest is zero-net-carbon energy.

Yes, biomass combustion emits CO_2. And yes, it's true that biomass utilization can be less efficient, in terms of CO_2 emitted per unit of energy produced, than fossil fuels in conventional thermal and power plants. And while it is true that a molecule of emitted CO2 has the same warming impact regardless of its source, it does not necessarily follow that emissions from biomass combustion should be treated as new net-positive CO2 added to the atmosphere.

If biomass energy feedstocks come from working forest systems in which harvested wood is continually and in real time completely replaced by new growth — the substitution of this energy source for fossil fuel eliminates fossil emissions without adding any new and net incremental CO_2 to the atmosphere at the time of combustion.[4]

A market for sustainably sourced bioenergy creates incentives for better forest management and the maintenance of net carbon stocks, particularly on privately owned lands.

Many criticisms of forest bioenergy make the mistake of not distinguishing managed working forests, like those in the southeastern U.S. that are managed in such a way as to maintain net carbon stocks, from other types of forest landscapes, such as conservation lands.

The private working forest landscape in the Southeast is managed to continually produce an array of products into the forest products market, only a small portion of which are bioenergy feedstocks. And by "managed" we mean that harvest, growth, and regeneration are constantly occurring across the forest landscape so that when one stand is harvested, the carbon removed from that pool is being returned by new growth elsewhere on the landscape[5].

While one could argue that the most climate beneficial management approach would be to let forests grow unfettered without ever harvesting them, that scenario is not the relevant or realistic "counterfactual" *for private working forests, particularly in the SE, which is one of the most productive commercial wood-producing regions in the world.*Rather, research on this question suggests that the opposite is true.

Absent demand for forest products – including an economic outlet for low-value fiber such as that used for energy — the working forest landscape in the U.S. Southeast would grow more slowly with respect to the amount of merchantable timber they produce or possibly even decline, and therefore would likely sequester less carbon.[6]

We know this because there is a positive relationship between forest harvest and forest growth in these landscapes: somewhat counterintuitively, it is the profitable harvest of trees that give landowners the reason to continue actively managing these forests for growth and bioenergy markets are a key part of these economics (providing a market for low-quality material harvested from the forest but undesirable for other uses).

And if these working forests are not producing profits for the landowner there is the additional risk they could be converted to another revenue-generating use involving the clearing of part if not all of the forest – the worst possible climate outcome.[7]

For managed working forests, a focus on the temporary CO_2 emissions of a given isolated harvest misses the larger climate-relevant point.

Without question, harvesting and combusting biomass from a forest stand results in net emissions*from that forest sub-unit* until the stand in question regrows biomass equal to what was harvested from it.

But for a working managed forest landscape, at any given time, across all the different stands that make up that landscape, the forest is yielding emissions from those units being harvested *while simultaneously* sequestering carbon as a result of new growth and regeneration in other units harvested previously. This is how sustainably managed working forests have always operated.

Every year in the southeastern U.S., 2% of the working forest is being harvested while the remaining 98% is in various stages of regrowth (and within that 2%, several different forest products are produced, a small but economically important portion of which is biomass for energy use). The International Energy Agency (IEA) has described the role of bioenergy production in sustainably managed forests:[8]

Biomass extraction for energy is one of many interacting factors influencing the development of forest carbon stocks, including forest product markets, forest ecosystem structure and management, and natural conditions. Silvicultural operations and harvest activities are coordinated across a forest landscape to maintain a healthy forest and to obtain a continuous flow of wood for society, while maintaining or increasing wood volume in the forest. Carbon losses in some stands are balanced by carbon gains in other stands, so that across the whole forest landscape the fluctuations in carbon stock even out.[9]

Building a carbon accounting policy framework for working forests by attempting to model emissions and sequestration for an individual tract at the stand level ignores the carbon that is being re-sequestered by the re-growing portions of the previously harvested landscape; only simultaneous analysis of emissions and regrowth can determine the net climate impact of a given landscape. The production of wood in response to market demand is enabled by the simultaneous management of a very large number of stands on the landscape, not by management of one individual tract over time.

If there is net sequestration at the scale of the managed forest landscape, then a specific harvest within that landscape is*not* a net emission that must be "accounted" for; the climate is receiving a net CO2*benefit* or dis-benefit depending on the change in carbon stocks on that managed forest landscape. Themanagement of the working forest system *as a whole, land-use trends, changes in carbon stocks, net storage in long-lived products as well as the impact on the use of other products*determines the net climate impact.

For those steeped in the language of corporate carbon accounting, net climate impact is how we do carbon accounting and reporting. One could analogize to how a corporation reports and tracks greenhouse emissions. A given factory or

facility, for example, may produce an increase in emissions (as might a portion of a working forest), but if other units of the company reduce their emissions correspondingly, the company reports no net increase in emissions.

Similarly, if there is a net increase in carbon stocks year over year in a given working forest landscape then the use of forest products for energy should not be "assigned" emissions independent of the net sequestration of the working forest landscape from which they came.

An approach that focuses on actual, measured changes in carbon stocks over time is more practical and offers greater assurance of climate benefits than an approach that relies on speculative modeling and unrealistic "counterfactuals".

Some forest bioenergy critics take the position that climate benefits should be assessed by comparison to modeling scenarios that assume no forest harvest at all, or perhaps no forest harvest for energy purposes. Modeling is not the best way to formulate a carbon policy, because modeling alternative scenarios is complex and necessarily entails numerous assumptions and as a result to date has proven ineffective at predicting future trends.

Modeling inevitably includes the heroic assumption that a model can reliably predict what would happen to future markets for forest products absent the additional driver of demand for energy applications. And perhaps more importantly, a counterfactual of unfettered growth with little or no harvesting is simply not applicable for most private working forests such as those that are prevalent in the southeastern U.S. Without harvest (and the income it generates), some portion of these forests assets is likely to be converted to crops or other non-forest uses.

There is no need for speculative modeling: measured data can be used to determine if the forest landscape is, in net, sequestering or losing carbon. If (and only if) it is net sequestering, then energy from biomass harvested from that landscape should be treated as carbon-neutral. The European Union's proposed clean energy policy follows this approach.[10]

Far from labeling all biomass, regardless of its source, as "carbon neutral," a landscape-level, carbon stock framework for managed working forests appropriately bounds the designation of climate-beneficial forest biomass energy.[11]

Such a carbon accounting policy approach, along with other non-carbon environmental safeguards, will help maintain a viable forest products industry, incentivize sustainable forest management, and ensure that appropriately-sourced bioenergy remains available as an alternative to fossil fuel use.

Policies pertaining to forest bioenergy, whether they are imposed by governments or adopted voluntarily, must reflect several key points:

- We should not categorically remove forest biomass from our climate mitigation toolkit and we need not label all biomass as "carbon neutral". We should use biomass from landscapes where carbon stocks are stable or increasing and where adequate sustainability standards are met.
- Owners of working forests are more likely to manage their assets in ways that foster stable or increasing carbon stocks when markets for forest products are robust. Perhaps counterintuitively, research suggests that increased demand for forest biomass can lead to management practices that are more likely to maintain forest carbon.
- Modeling is not needed to apply this framework, since there is an existing robust system for providing actual regional inventory data can be used to directly quantify carbon stocks at the landscape scale.
- Important international scientific bodies and environmentally progressive governments support the landscape carbon stock approach.
- The landscape/sustainable harvest approach will give would-be bioenergy consumers clear guidance as to a carbon neutral subset of biomass they can source.
- Simply limiting biomass energy use to very narrowly sourced feedstocks (such as sawmill residues) will miss the opportunity to further reduce net carbon emissions to the atmosphere as the supply chain will be inadequate to enable fossil users to invest in conversion; these users will

transition to lower carbon options only if they can secure a supply base at scale that can guarantee bankable delivery.

As in most energy and climate debates, the issues surrounding forest biomass are complex. All energy production technologies, including options like wind and solar, have advantages and drawbacks, and all have elicited legitimate environmental concerns. Biomass is no exception and its specific attributes mean that it will be important to apply robust sustainability criteria and other environmental protections—including tracking of net carbon stocks in source forests—as a condition of using additional wood for energy production.

But biomass has advantages, in terms of supply reliability and compatibility with existing energy infrastructure that can accelerate the displacement of fossil fuels in the near term. A policy based on unrealistic counterfactuals or that focuses only on the carbon impacts in only a subset of a larger working forest misses the forest for the trees, so to speak, and risks foregoing a low-carbon energy option that—given the scale and urgency of the climate challenge—we can ill afford to lose.

By Roger Ballentine[1] and Jennifer Jenkins[2]

1 Roger Ballentine is the President of Green Strategies, Inc. He served as Chairman of the White House Climate Change Task Force under President Bill Clinton and is the Co-Chair of the Aspen Institute Clean Energy Innovation Forum.

2 Jennifer Jenkins is Vice President and Chief Sustainability Officer at Enviva Biomass. She holds a PhD in ecosystem ecology from the University of New Hampshire and a Master of Forest Science from Yale University's School of Forestry and Environmental Studies.

3 In the current environment it is hard to separate the details of any EPA policy from its controversial Administrator. We don't here defend or dissect what EPA did, but EPA has not indicated that carbon neutrality is assumed automatic under all circumstances and for all time: EPA has committed to revisit its policy should the trajectory of US carbon stocks shift. Irrespective of EPA's policy, we

suggest a narrow framework that can put the right biomass into our climate toolkit.

4 Of course, the production and transportation of bioenergy products like pellets have emissions associated with them. It is the same with the production and transportation of Chinese solar panels. We do not attribute such supply chain emissions to the emissions rate of the energy eventually produced.

5 Note that typically a share of the carbon removed from the forest – the portion of the harvested timber that is sold into sawtimber markets – is stored over the long term in harvested wood products, providing additional sequestration. Far from reducing these climate-helpful uses of forest biomass, a market for low value fiber such as for bioenergy helps support the economics of these uses.

6 According to a report published in July 2017 by Forest2Market that examined data from the U.S. Department of Agriculture's Forest Service Forest Inventory and Analysis for the southeastern U.S. over the six decades from 1953 to the present. Over that period, the data confirm a positive relationship between forest harvest and forest growth, indicating that landowners responded to a stable market for forest products by planting more trees. Jefferies, H.M., T. Leslie. 2017. Historical Perspective on the Relationship between Demand and Forest Productivity in the US South. https://blog.forest2market.com/forest2market-report-shows-increased-demand-for-wood-fiber-leads-to-forest-growth

7 Dale, V. H., Kline, K. L., Marland, G., & Miner, R. A. (2015). Ecological objectives can be achieved with wood-derived bioenergy. The Ecological Society of America Frontiers in Ecology and the Environment, 297-299.

8http://www.ieabioenergy.com/

9https://www.chathamhouse.org/sites/files/chathamhouse/publications/2017-04-05-IEABioenergy.pdf

10 The current version of the EU's RED2 package, "Clean Energy for all Europeans," considers the use of U.S.-sourced biomass in stationary facilities

such as power plants as a greenhouse gas reduction tool only if the biomass is sourced from a supplier whose forest stocks are stable or increasing. As agreed by Plenary Vote in the EU Council on December 18, 2017 and by Plenary Vote in the EU Parliament on January 17, 2018.

11 Moreover, there is little potential for detrimental "leakage" from these forests whereby increased demand for bioenergy from managed forests shifts overall demand and results in increased harvesting from forests that are not managed for continued growth. The decline of the region's pulp and paper industry since the 1980s (due to a broader reduction in demand for paper and printed products) has made an abundance of low-quality feedstocks available. Woodall, C. W., Ince, P. J., Skog, K. E., Aguilar, F. X., Keegan, C. E., Sorenson, C. B., . . . Smith, W. B. (2012). An Overview of the Forest Products Sector Downturn in the United States. Journal of Forest Products, 595-603. Further, even if concerns remained about demand for feedstocks increasing to the point where local leakage became a problem, these concerns could be mitigated by monitoring the forest landscape over time to ensure that overall carbon stocks are stable or increasing. Provided the landscape carbon stock analysis is conducted over an area large enough to capture any effects of leakage outside a given producer's supply region, this approach would provide confidence that the use of the producer's feedstocks for energy purposes is not leading to additional greenhouse gas emissions.

Photo Credit: Andrea Kirkby via Flickr

Mr. Thomas Carpenter

Designated Federal Officer

US Environmental Protection Agency

Science Advisory Board

Washington, DC

Thank you for sharing the draft SAB review of the framework to assess biogenic CO2 emissions from stationary sources. As you know I was part of the earlier panel that wrote previous drafts and therefore am very aware of the conversations and analyzes that went into those efforts. I was not part of the current panel, nor was I consulted. I point these facts out to just make it clear that I may have had some indirect influence on the current draft.

My comments are at two levels: general ones versus specific ones referencing particular pages and lines. For some comments the topics are related.

My general comments are as follows:

I agree that it is more appropriate to use a policy-based assessment period than the time at which all (to most) terrestrial carbon stores effects are completed. Despite being in agreement I did not find that the arguments being offered in the report were particularly convincing. At best they seem incomplete and given that this is probably the most contentious issue at this point I believe this is a critical mistake. I have several reasons that I don't believe there is a single, scientifically based time that can be used to assess the BAF's. I believe that mathematically there is a good rationale to assess the BAF when the difference between the reference and policy scenario ceases to change. This indicates when the direct carbon effects have largely ceased and it also is a time at which the BAF starts to act as a hyperbolic function. However, there are other mathematically important and objective times that could have been selected such as the time of the peak BAF value. This means there is no unique time that can be defined by science or mathematics which undercuts one of the rationales offered in the previous panel's report. Another factor is whether the time of assessment is strictly a scientific decision. I do not believe that it is, in part because to understand the full impact one must weigh not only the carbon science, but also the science of climate, ocean acidification, etc. Unless these all act the same as the carbon response, then one must make some sort of subjective judgement as to how to combine scientifically determined assessment times that differ. That is really a job best handled in the policy arena.

The report seems to have either misunderstood or redefined the concept of T. In the old system T is a particular time when particular things happen regarding the carbon dynamics. However, the current report seems to have redefined that to be the policy assessment time but does not describe this conceptual change and only seems to define the new term many pages after it is used. Unfortunately the report uses figures that use the old concept of T and refers to reports that use the old concept. This has created a very confusing situation. I would encourage the panel to keep T as its original concept as it has value as a concept even if it is not used to determine the assessment time. That way old the old

material does not have to be revised. The panel can then come up with a new subscript to designate the policy time (e.g., A for assessment, At for assessment time, P for policy or Pt for policy time, Pat for policy assessment time, etc).

I believe that the report is correct that this problem is most practically solved by examining multiple areas contributing to the plant(s) over time. To make this concept less awkward this has been described as the landscape scale or level. Unfortunately there are two problems when this is done. One can also look at the problem at the level of a fuel shed or at the level of a region, or the globe. So it is not a strictly landscape level that is being recommended. And because of this language it is not clear why a regional approach is being recommended in other places in the document if the landscape level is the only level to examine the problem. This brings up another point that is not clear in the draft report: there is a difference between moving beyond the stand level to do the analysis in terms of a concept and a method. The problem is that the report seems to suggest one method when it probably means to say one concept. In terms of methods one can certainly model an idealized stand and scale it up to the landscape/regional level, or one could model multiple stands in a broader area or use a distributional model, or use a spatially explicit model and even model the broader area as one entity. The point is that for the same concept there are numerous ways to methodologically address the problem. None of them is correct or wrong; they have different strengths and weaknesses.

In numerous places the report refers to updating the baseline as new data becomes available. As described in the report this is quite problematic especially at the regional level. What the report seems to suggest is to use the response of the region being impacted by biogenic fuel harvests to update the reference scenario. This would clearly conflate the two scenarios. Since the difference between a scenario and itself is zero, this would lead to underestimates of the BAF's over time. I don't see a problem with using new information to test assumptions, strengths of interactions, provide better parameter estimates. But I do see a major problem with resetting the reference baseline to match the responding region. Either the report has to explain why there would not be a conflation of the two scenarios or more clearly explain how the new information would be used to avoid this very serious problem.

In this and in previous reports the focuses too heavily biased on much on growing stock effects and not on ecosystem effects. The latter is the relevant concern because it is the response ecosystem that is controlling the net carbon flows. While the term feedstocks is used throughout the draft, the distinct impression is given that this is about growing stock. This is unfortunate because the carbon response might come from the growing stock (i.e., plants) or from the detritus from them (i.e., feedstocks related to waste or slash) or from something that is never harvested (i.e., mineral soil C). By using the term feedstocks the report seems to be prejudging whether there will be mineral soil C responses. I do not believe that there is any scientific basis for this assumption, and while I recognize that some have suggested that mineral soil C responses will be minimal, this is not a scientific statement, it is an aspirational one.

Throughout the report there are recommendations to use the simplest, least complex model. While I certainly do not recommend using the most complex model conceivable, it is not a good idea to use the

simplest model to analyze a problem. The model needs to be as complex as it needs to be to capture the different behaviors of the parts and to represent the interactions between them. If the system has key feedbacks it is always easier to ignore these in a simpler model and they often are. But that will mean the behavior is not correct because you actually aren't modeling the system you are interested in examining. I urge that the panel revise this language because it is quite misleading in terms of how one actually decides on which model to develop or use.

I agree with the recommendation that any models that are used be tested, subjected to sensitivity analyses in terms of assumptions, parameters, and general structure. However, these recommendations are overly generic and seem to skirt the idea of reporting the uncertainty or even what to do with that information. They also seem to miss the point that models need data to drive them and that uncertainty in that data/model can then impact the model predicting carbon responses. The report also seems to suggest by omission that the assumptions, parameters, and general structure of ecological models are about as uncertain as economic ones. The impression given is that if there is a longer list for one kind of model than other, that the former has more uncertainty. I think this is very misleading because it is not the length of the list one can craft; it is the degree of uncertainty about each item on the list. While there is certainly plenty of uncertainty about ecological models, many aspects about the kinds of entities, the processes, and interactions are quite well known. And while there is uncertainty about ecological parameter values, these are often well bounded by data and theory. The same cannot be said of economic models, which in some cases are still trying to understand the form and strength of various connections. There are good reasons for this state of affairs, the problems involved are quite challenging, but that does not change the current state of economic models.

The report is quite inconsistent about its recommendation regarding the two cumulative BAF's. In some places the BAFt is recommended but in other places it suggests that both be studied further. It also seems to suggest that little is known about how the BAFsigmat behaves. I find that to be a very misleading statement. The past panel did a lot of work on analyzing how these acted relative to each other for a wide range of cases and it provided and explained the mathematical relationship between the two cumulative indices. While I am sure that more needs to be learned, I think that is true of both cumulative BAF's. Therefore the report needs to be revised to recommend that both cumulative BAF's be further studies and to state that without the bias the current report contains.

Because the current report is lacking in many details the only location one can currently find them is in past reports. However, the current report provides the reader no effective connection to the past report. This is a major issue that needs to be addressed. Many of the details concerning the definition of terms and concepts, formulation of the BAF's, the analysis of their behavior, and scaling issues are found in appendices of the previous report. While it is good to provide a web link, the current report needs to provide more detailed guidance as to the general location to key sections. As it is the reader is not even alerted as to what they should be looking for. This does a disservice to the reader, but also devalues all the previous work that was done that is quite independent of the contentious issues.

While I believe that the current document makes some important improvements there are numerous problems in terms of concepts, terms, definitions, and overstatements (see below). Before this report is fully considered I believe these have to be addressed.

Sincerely,

Mark E. Harmon

Professor emeritus, Oregon State University

Specific comment

I have numerous specific comments which are referenced to the page of PDF document/line on that page.

2-29 While it is important to refer to the past materials, it is even more important to refer the specific sections and appendices that define terms, present equations, and provide examples. These need to be referenced in later text to make the connections clearer. To do otherwise will mean that access to critical material will be largely obscured.

12-13 It is not clear what soil represents in this context. Is this just the mineral soil? The non-living plant part of ecosystems? Does this exclude dead organic matter? This needs to be clarified because it could be taken to exclude from consideration logging slash, salvage of dead woody parts, even removal of the forest floor. This sentence is also not consistent with how this term seems to be used later which is the more restrictive use.

12-31 I don't think one can state categorically that the boundaries are always absent. That would depend on the power plant and the source. It would be better to qualify this in some way by stating the boundaries can be difficult to define in some cases. Possible absence would probably be a better way to state this.

12-37 I do not think that "and/or" makes any sense in this context. It would not be possible to assess the BAF's if the ecological portion of the system is neglected. That is because it is the part of the system that actually stores the carbon. One must view this hierarchically, with the ecological system nested within the larger ecological-economic system. This needs to be revised to reflect that hierarchical arrangement.

12-39 I do not believe that the statement "simple models are often best" belongs in this document. The best models are the ones that achieve the required objectives and include all the essential parts and interactions. They are as complex as they need to be, because being simpler means that the system being examined is not being examined. Best also depends on the question being asked, the level of resolution needed, the trade- off between generality and realism. Since none of this has been specified it is largely a meaningless statement that seems to reflect someone's particular bias.

12-41 In this context it is not clear what the "last increment" means. How is the last one defined? Is it the last one before the assessment time? Or the last one possible?

13-1 While I agree that much of this information is important to consider and use in models, as written this seems to suggest the future response can be predicted from the past response. Given that much of the proposed expanded biogenic carbon harvest is novel and in the future, it is not clear how these data could be used directly. That is, how does one use past empirical data to predict a novel response? You can't. This logical problem in the document needs to be resolved.

13-12 The approach of adjusting the baseline does not really make any sense at all as written. I believe that it is important for future information to be used to test model responses, assumptions, parameter estimates. However, periodically adjusting the reference baseline would potentially create a situation in which the reference and policy scenarios (to use the terminology of the previous panel's work) become conflated. The only way this would not occur is if the areas in a region influenced by the biogenic carbon harvest can be separated from the ones that are not. Moreover, if there is any preference in terms of site productivity, species, management, etc between the two subregions representing the two scenarios then one would risk mistaking the actual cause of differences. I believe that this proposed approach needs to be reconsidered or described in a way that would actually work.

13-14 On what scientific basis can it be stated that carbon stocks always increase? That is what is implied by this statement. I suppose one could say changes in carbon stocks, but this raises the question of how one avoids conflating the two scenarios needed to make the BAF calculations.

13-16 While I have a very broad use of the term model, I do not see how the choice of the kind of reference system selected is a model in any sense. It is certainly part of the assessment framework, but it is not a model because it does not predict anything.

13-24 I do not see how the data underlie the models. I can see how some data might be critical to assessing models or re-parameterizing them, but this is written as if the model will be solely empirical. Limitations on the type of model to be used should not be part of this report.

14-20 It should be stated that the changes are made relative to a reference scenario. That is an essential element of the system that needs to be repeated throughout the document.

14-41 I strongly disagree that one of the cumulative BAF's should be preferred at this time over another. "more needs to be learned about how they differ" is a very dubious statement. The previous report had numerous examples to illustrate the differences and described how they relate to each other mathematically. This statement introduces a bias that is not based on science and essentially ignores all the work the previous panel did. I believe EPA should do more work to examine the two cumulative BAF's but this statement basically has the effect of discouraging further work by EPA. This statement also does not accurately reflect the detailed material below.

14-42 There is a contradiction between using BAF_T and the policy horizon approach being recommended. The use of a capital T signifies the time at which the difference between the policy and

reference scenarios stabilizes. That approach is not what is being recommended. To be consistent with what is being recommended the lower case t should be used because that refers to any value of time that one selects. Or the panel can create a new subscript that is not in conflict with the other sections and past work.

15-1 Again the lower case t should be used in this context.

15-7 Again, what does the last effect mean exactly? How is this relevant to the ecological response?

15-10 What does reasonable mean and how can that be scientifically quantified? Reasonable will vary from person to person and from time to time.

16-19 They also could reflect changes in stores associated with other types harvest if bioenergy is using some of that carbon. Bioenergy generation has already started to compete with particle board production and that is reducing the stores in wood products in use. So this needs to be generalized to include all the carbon related to forests, not just what is in forests.

16-37 Again, it is good to have a general link to past material, but in the later sections one needs to refer to specific parts of the previous reports, particularly the appendices that more fully explain the calculations, the concepts, define terms, etc.

18-5 See comments above about conflating the policy and reference scenarios. This is an extremely problematic approach which sounds reasonable, but would actually create problems.

18-14 See comment for 16-19. The statement at 18-14 makes more sense, but it in conflict with the one on 16-19.

18-21 True, but probably irrelevant as EPA will be doing the modeling for the most part. Given this why is this statement needed in the report?

18-36 This would also require use of models and not just use of data. This should be generalized to "additional information" or expand it to "additional data and modeling".

19-3 I think it is very confusing to refer to these as influencing the BAF's. The BAF's are just formulae that make the estimate. The calculations are not impacted by the source of information. What seems to be referred to are BAF estimates or values. That makes sense, but influencing the BAF calculation itself does not. Perhaps this is just a case of using jargon, but it needs to be addressed.

21-8 Why does carbon dioxide only have a climate impact? What is the scientific basis of that statement? Are we seriously to believe that there are no ocean acidification impacts of releasing carbon dioxide into the atmosphere? This should be generalized to environmental impacts and not be so centered on climate effects.

22-4 It would be better to state that the harvest is likely to be regulated. There is no science that can predict that it will always be regulated as implied in the current version of this statement. However, there are other issues with this section. The idea that the harvest is regulated only applies to a forest

system. In an agricultural setting there is not really a rotation as this seems to imply. It is entirely possible that the fuel would come from the same land area year after year. In an agricultural system the losses and gains might be fairly synchronous from place to place. So the concept of asynchrony does not work particularly well outside the forest sector. This would be solved if it was made clear that this section is referring to a long-term perennial system such as a forest.

22-7 I think it would be better to state that stand level are not necessarily relevant. That is because one can certainly scale up stand-level results to the landscape and in that case they are certainly relevant.

22- 8-9 It is important to mention the comparison to the reference scenario all possible reactions. Right now it is only mentioned in the case in which outputs exceed inputs. For the BAF's the key point is a difference between scenarios, it is not valid to compare a scenario to itself because scenario cannot be referenced to itself.

23-29. The modeling that was done by the previous panel indicates this is not the case. What is being mixed up here is the BAF delta t which would probably be zero for most by several hundred years, with the cumulative BAF's which are not going to be zero even after hundreds of years. One only has to look at Figure 1 to see that. If the T is 100 years, then the BAFt is not going to reach zero for a very, very long time. Even at 5 X T or 500 years it would not be zero as is stated here. This represents a failure to understand how the cumulative BAF's act over time.

23-34 I clearly missed where T was defined as the time horizon earlier. It was not defined this way in the previous reports and it does not match what is being used in Figure 1. I think it is a mistake to use T in a new way without defining it or considering how it conflicts with other concepts of time that have been used.

24-9 This is not how T is used in the previous documents that you refer to. This is just going to add confusion.

24-38 As stated above this makes no sense whatsoever. Clearly a model can be oversimplified and not be particularly useful to analyzing a certain problem. The simplest model of biogenic carbon effects is that stores do not change. That overly simplistic model has been offered repeatedly in past conversations about BAF's. It is clearly the simplest model, but is also clearly wrong. I urge the panel to be far more careful about statements of model simplicity.

25-41 This is a place where specific reference to the previous materials is needed. None of the terms used in the figures is defined and some of the definitions conflict with what is presented in the current document. This is bound to confuse anyone actually trying to use the current report.

26-28 As mentioned above this approach of a shifting baseline would potentially confound the reference with the policy scenario or conflate various causes. I think this is very problematic as presented.

26-41 While FIA measurements have been made for decades some of them are very recent, and some such as soil have not really be made in an appropriate way and some such as products are not inventoried at all. So while I agree that FIA data is important and useful, it has serious limitations that

need to be recognized. This seems to gloss over all the shortcomings and presents a very inaccurate image. Also one has to be aware that until the last decade or so the FIA database did not include US Forest Service lands, Park Service lands, wilderness areas etc. So to say it has been robust for five decades is not accurate at all and seems to border on a PR pitch.

27-1 This recommendation does not match the more specific one presented in the summary section. I think this is the correct recommendation: consider both at this point and do more analysis.

27-11 I don't think it makes any sense in revising the BAF's in the sense of the calculations. The BAF is always going to be a ratio of carbon changes divided by carbon emitted by combustion. What may change is the estimated BAF. There is a vast conceptual difference that is being missed here.

29-9 What is meant by biogenic factors?

29-30 Again, the BAF equation is not going to be influenced by the amount or novelty of the data. The BAF estimate might. There is a profound difference between the two. To quote Twain "being hit by lightning is not the same as being hit by a lightning bug."

Comments to EPA Science Advisory Board on the proposed accounting of carbon emissions from combustion of forest bioenergy.

Emeritus Professor William R Moomaw, Co-Director Global Development and Environment Institute, Tufts University and Board Chair Woods Hole Research Center

The attempt to find a way to account for forest bioenergy carbon *emissions* has been largely solved by the Life Cycle Assessment and Systems Dynamics Analysis of the carbon stock additions to the atmosphere over time. The use of arbitrary time frames and the debate over what is appropriate should replacement forest growth take place is no longer necessary. Following the carbon from trees to fuel to combustion release as atmospheric CO_2, and its potential removal by replacement tree photosynthesis is now well described by recent findings (Sterman et al, by Law et al, Birdsey et al and by Booth).

This full-time accounting of carbon as it moves through natural and human energy systems also allows direct comparison with alternative scenarios for producing heat and/or electricity. The result is that forest bioenergy adds more carbon dioxide to the atmosphere over time frames of a century or more than do alternative energy sources.

The other point to be made is that the focus on when – if ever – bioenergy becomes carbon neutral is the wrong question to be asking. Climate change needs to be addressed as rapidly as possible in order to avoid reaching irreversible tipping points. The goal that truly matters is clearly stated in Article 2 of the UN Framework Convention on Climate Change.

> "The ultimate objective … is to achieve… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

It is quite clear that current CO_2 and other greenhouse gases are already causing "dangerous anthropogenic interference with the climate system." Human activities have increased concentrations of CO_2 to 411ppm; well above the 280 ppm that prevailed before large-scale additions from all forms of combustion including bioenergy, and land use change including deforestation, destruction of wetlands and degradation of grasslands and agricultural soils. The combined removal of CO_2 by these terrestrial ecosystems reduces the annual increase of atmospheric CO_2 by about 30% by removing some 3 GtC/year from the atmosphere. (Le Quere et al)

Hence the counterfactual or alternative scenario to be considered is how much more or less atmospheric concentrations of carbon dioxide would there be if forest bioenergy were not used at all. How much more would forests grow and how much more CO_2 would they have absorbed and removed from the atmosphere had they been able to continue growing instead of being cut and burned? How much larger would the terrestrial carbon sink be in this alternative scenario? The carbon is either in the trees and soils and ocean, or it is in the atmosphere.

It is now well established that larger older trees store the bulk of carbon in the living biomass of the forests. A recent study of 48 forest plots in all types of forests found that half of the carbon in living biomass is stored in the largest one percent diameter trees (Lutz et al). Additional studies show that half of all the carbon in forests is in soils and dead biomass (Birdsey, Moomaw et al). In other words, forests made up of larger, older trees hold more carbon than do younger smaller ones. Also, because many species can live for several centuries, they continue to add much larger amounts of carbon in their middle to later years than do forests made up of younger smaller trees.

It is often argued, "sustainable forest management is carbon neutral." That is usually taken to mean that continual annual harvests take no more carbon than grows in that year. This assumes that replacement trees are only removing and storing carbon from the previous combustion of wood many decades before, and ignores the fossil fuel carbon removal that has been displaced. What is also missing from the analysis is the carbon stock in the forest. With short rotations, the stock of stored carbon is small, and so there is always more carbon in the atmosphere.

Applied to the carbon balance for a forest sustainably managed for bioenergy this has a further important implication. Suppose a forest is harvested after 50 years for bioenergy, and it is burned immediately, releasing carbon into the atmosphere. A replacement forest must then grow for at least 50 years to assure carbon neutrality. The economic benefit of that future CO_2 removal should be appropriately discounted. Physically, during that time, the concentration of CO_2 in the atmosphere is greater than it would have been had the trees not been cut and burned and trapping additional heat. The extra CO_2 has irreversible consequences, acidifying the oceans, and the warmer temperature melts ice and increases sea level. These changes are not reversed once the replacement forest has grown in 50 years. *Carbon neutrality* is not the same as *climate neutrality.*

It is important to consider an alternative scenario that spans several harvest cycles. If allowed to continue growing instead of being again cut and burned, the forest would sequester substantially larger amounts of carbon dioxide during the additional 50 years than in the initial 50-year interval. The stored carbon additions will continue to increase well into the life of the trees, and may continue to do so for several centuries instead of decades (Birdsey et al). If we are to actually reduce atmospheric carbon dioxide concentrations, it is essential that we stop adding carbon dioxide from all combustion sources including bioenergy, and increase the removal rates and carbon storage in terrestrial ecosystems including forests. Long-lived forests are our best option for increasing negative emissions over time.

In the discussion above several important additional sources of emissions from bioenergy have been left out. Forest bioenergy releases more CO2 per BTU or kWh than any fossil fuel at the stack. Significant amounts of fossil fuel energy are required to produce commercial scale wood pellets and chips, and not all of what is harvested is utilized in the final fuel. Each successive harvest removes soil nutrients that must be added in the form of fertilizer, and the nitrous oxide from fertilizer substantially increases radiative forcing. There is no enforcement mechanism to ensure a replacement forest is planted. In short,

forest bioenergy cannot be justified on grounds of being a low carbon energy source. Fortunately, there are many alternative low carbon technologies to produce electricity and heat.

References

Richard Birdsey, William Moomaw, Richard Houghton, Wayne Walker, Phillip Duffy (2018). "Limits to Growth of Forest Biomass" Underestimates Carbon Sequestration Potential of Old-growth Forests, Nature Communications (In Press)

Richard Birdsey Philip Duffy, Carolyn Smyth, Werner A Kurz, Alexa J Dugan and Richard Houghton (2018). Climate, economic, and environmental impacts of producing wood for bioenergy. Environmental Research Letters, Volume 13, Number 5, **http://iopscience.iop.org/article/10.1088/1748-9326/aab9d5**

M S Booth, Assessing the net emissions impact of residues burned for *bioenergy*. To cite this article: *Mary* S *Booth* (2018) Environ. Res. Lett. 13 035001.

Beverly E. Law, Tara W. Hudiburg, Logan T. Berner, Jeffrey J. Kent, Polly C. Buotte and Mark E. Harmon (2018). Land use strategies to mitigate climate change in carbon dense temperate forests. PNAS April 3, 2018. 115 (14) 3663-3668; published ahead of print March 19, 2018. https://doi.org/10.1073/pnas.1720064115

LeQuere et al (2018). Earth Syst. Sci. Data, 10, 405–448. https://doi.org/10.5194/essd-10-405-2018

James Lutz et al Inequality is Normal: Dominance of big trees (2018). Global Ecology and Biogeography https://onlinelibrary.wiley.com/doi/abs/10.1111/geb.12747

John D Sterman, Lori Siegel and Juliette N Rooney-Varga (2018), Does replacing coal with wood lower CO_2 emissions? Dynamic lifecycle analysis of wood bioenergy, 2018. Environment Research letters, Volume 13, Number 1. http://iopscioence.iop.org/article/10.1088/1748-9326/aab512

NAFO

National Alliance of Forest Owners

September 19, 2018

Sent via electronic mail

Mr. Thomas Carpenter
Designated Federal Officer
Science Advisory Board
Environmental Protection Agency
Mail code 1400R
1200 Pennsylvania Ave. NW
Washington, DC 20460-4164

Re: NAFO Comments on SAB's Draft Report on EPA's 2014 "Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources"

The National Alliance of Forest Owners ("NAFO") thanks the Environmental Protection Agency's ("EPA" or "the Agency") Science Advisory Board ("SAB") for this opportunity to comment on its Draft Report on EPA's 2014 "Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources" (the "Draft Report").

NAFO is a national advocacy organization committed to advancing U.S. federal policies that support the long-term economic, social, and environmental benefits of sustainably managed privately owned forests. NAFO member companies own and manage more than 45 million acres of private working forests to provide a steady and environmentally sustainable supply of timber. NAFO's membership also includes state and national associations representing tens of millions of additional acres.

NAFO seeks common sense policy solutions to sustain the ecological, economic, and social values of forests and to ensure an abundance of healthy and productive forest resources for present and future generations. Approximately 360 million acres—or 70%—of the working forests in the United States are on private land, owned by individuals, families, small and large businesses, and an increasing number of Americans who invest in working forests for retirement. Private U.S. working forests support 2.4 million U.S. jobs, $99 billion in payroll, and $282 billion in sales and manufacturing. These working forests are vital to our nation's natural resource infrastructure, providing forest products, open space, wildlife habitat, clean water and air, recreation, and more. U.S. forest owners are the world's leaders in sustainable forestry.

Individual states administer the world's most effective framework of forestry laws, regulations, and agreements in a way that is carefully tailored to local conditions and needs.

NAFO confines its comments to three topics addressed by SAB in its Draft Report: biogenic CO_2 emission decisions being made in a "policy context"; biogenic assessment factors calculated using forest inventory data at a broad spatial scale; and the reference point baseline as the preferred baseline approach.

I. *Biogenic Carbon Accounting in a Policy Context*

In EPA's 2011 "Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources," the Agency provided SAB with a specific policy context: assessing biogenic CO_2 emissions for Clean Air Act Prevention of Significant Deterioration permitting decisions. EPA removed this policy context in the 2014 Framework, instead asking the SAB to provide policy-neutral guidance on issues related to temporal, spatial, and production scale determination of BAFs.

SAB in this Draft Report recommends to EPA that "future efforts to define specific biogenic accounting factors should be conducted in a policy-specific context, with the objectives and relevant time frame specified." Draft Report at 6. SAB makes this recommendation based on its assertion that "[b]iogenic carbon accounting will vary depending on the policy context, particularly in selection of the time horizon and geographic scope." *Id.*

NAFO appreciates SAB's perspective on making future assessments about biogenic CO_2 emissions based on specific policy objectives. Even though EPA removed the policy contexts in its 2014 Report, the SAB's recommendations give EPA and other policymakers appropriate guidance for future rulemakings on biogenic CO_2 emissions. These recommendations will enable EPA and other policymakers to base their rulemakings on clearly defined policy objectives and use science to inform the most appropriate pathways to achieve those objectives.

Applying this approach greatly simplifies EPA's determination of at least two aspects of a biogenic accounting framework: (1) the particular timescale of a policy objective (Draft Report at 10), and (2) policy impacts on feedstock-specific demand (Draft Report at 18). Regarding the first, EPA will establish the timescale for assessing the policy outcome as a policy objective (e.g., mitigating greenhouse gas emissions by 2025 versus mitigating emissions by 2050, or some other time frame). Since biogenic CO_2 emissions are part of a global carbon system, a determination by EPA to achieve its policy over a long time frame consistent with the natural cycles within that system would be appropriate.

In sum, NAFO agrees with the position that any views on the relationship between policy objectives and accounting methodologies should and will be determined by policymakers.

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II. *Calculating Carbon Impacts at a Broad Spatial Scale*

NAFO agrees that calculating carbon impacts using forest inventory data at a broad spatial scale properly reflects the way forests are managed, biomass feedstocks are produced, and geographically overlapping forest product markets operate.

A. Broad Landscape-Level, Rather Than Stand-Level, Approach

NAFO supports SAB's conclusion that when accounting for impacts on carbon stocks, a stand-level or facility-level approach is inappropriate. SAB's recommendation about a broad landscape-level approach best reflects this reality by "expand[ing] the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and credits that determine carbon stock effects." Draft Report at 8-9.

Calculating carbon impacts at the broad landscape level builds on the spatial scale at which forest owners and managers develop and implement their management plans. Forest owners and managers design these plans to produce diverse age classes and a constant supply of harvestable forest product over long timescales. This extended approach results in CO_2 emission and sequestration happening simultaneously, which means that emissions from harvesting are offset on a continuous basis by forest regeneration that is occurring on many other stands that are not being harvested.

The principle of accounting at the landscape level, given the forest management practices employed in the real world, is also supported by scientific research. As research by Olivia Cintas cited in SAB's Draft Report states: "[w]here management activities are coordinated across the whole landscape to obtain a continuous flow of wood for the forest industry, calculating carbon balance at the landscape scale can be more appropriate … Carbon losses in some stands are balanced by carbon gains in other stands, so that across the whole forest landscape the carbon stock follows a trend line that can be increasing or decreasing, or roughly stable over time."[1] And, "[a]ssessment at the landscape scale integrates the effects of all changes in the forest management and harvesting regime that take place in response to—experienced or anticipated—bioenergy demand."[2]

B. Forest Markets Dynamics

The forest practices and their associated carbon impacts are dynamic not only because of the management plans developed and implemented by forest managers, but also because of the global and overlapping markets for forest product streams. As SAB notes, "the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, policy, market forces, or natural causes." Draft Report at 9.

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[1] Olivia Cintas, et al., "Carbon balances of bioenergy systems using biomass from forests managed with long rotations: bridging the gap between stand and landscape assessments," *Global Change Biology Bioenergy* 1239 (2017) (internal citations omitted).
[2] *Id.*

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The broad landscape-level approach best reflects the national and global integration of the forest products industry, including biomass energy producers. Individual producers obtain their supplies from a large and geographically diverse array of forest owners and suppliers; and producers compete with one another in a national, and sometimes global, marketplace. Isolating impacts on a scale smaller than the landscape level is nearly impossible and would lead to a skewed accounting methodology that is not based on real world forest management and marketplace conditions.

III. *Using the Reference Point Baseline and Data as the Preferred Approach to Carbon Measurement*

As NAFO has stated in past comments, consistent with SAB's review of EPA's 2011 Framework, the reference point baseline is the only baseline option that can viably be implemented in a policy or regulatory context. An anticipated future baseline may provide theoretical appeal, but its practical applicability is limited because it is too complex and uncertain.

NAFO's preference for the reference point baseline is consistent with the findings of Thomas Buchholz and his research team, also cited by SAB, which states: "[A]n anticipated future baseline has one major caveat: being a forward-looking tool relying on additional assumptions beyond measurable data points (as applied with a constant reference point baseline), the uncertainty associated with an anticipated future baseline increases over time," and that "[g]iven the challenges in predicting the future status of forest resources, . . . constant reference baselines might be more appropriate for monitoring and regulatory frameworks."[3]

A reference point baseline allows EPA to employ a data-based methodology that can rely on the U.S. Forest Service's Inventory and Analysis ("FIA") program, which is the world's most comprehensive forest data collection and measurement resource. The FIA program relies on actual forest plots to collect data on forestland on a state-by-state basis. Under the Forest and Rangeland Renewable Resources Planning Act of 1974, the Forest Service produces a nationwide assessment every 10 years. However, the annual collection of data would allow monitoring to occur between the 10-year assessments. Using the FIA landscape scale and timeframes mitigates the influences that transitory factors such as the housing cycle, weather, and forest age have on carbon stocks.

[3] Thomas Buchholz, et al., "Uncertainty in Projecting GHG Emissions from Bioenergy," *Nature Climate Change* 4:1045-47 (Nov. 26, 2014).

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IV. *Conclusion*

NAFO appreciates this additional opportunity to provide its views on these important issues. We believe that the guidance SAB has provided in this Draft Report is well-supported by comments made throughout the regulatory process, as well as by the numerous scientific studies cited and relied upon by SAB in this document. This guidance provides policymakers at EPA the necessary tools to move forward with policy and regulatory directives in addressing biogenic CO_2.

Thank you for your consideration of these comments. If you have any follow-up questions, please feel free to contact me.

Respectfully submitted,

/s/ William R. Murray

William R. Murray
Vice President for Policy & General Counsel
National Alliance of Forest Owners
122 C Street, NW, Suite 630
Washington, DC 20001
(202) 747-0742
cmurray@nafoalliance.org

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IMPACT. SCIENCE. SOLUTIONS.

Reid Miner
NCASI
1513 Walnut Street
Suite 200
Cary, NC 27511

September 19, 2018

TO: Thomas Carpenter, DFO, United States Environmental Protection Agency (sent via email to carpenter.thomas@epa.gov)

FROM: Reid Miner, Steve Prisley, Caroline Gaudreault - NCASI

SUBJECT: NCASI comments on the August 29, 2018 draft report for quality review from the EPA Science Advisory Board (SAB) on the topic of SAB's review of the 2014 draft *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*

NCASI is a non-profit environmental research institute focused on scientific and technical information addressing the environmental and sustainability needs of the forest-based industry in North America.

We appreciate the opportunity to comment on the August 29, 2018 draft report for quality review from the EPA Science Advisory Board (SAB) on the topic of SAB's review of the 2014 draft *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources.*

We wish to highlight four points relevant to the SAB review:

- Policy makers need to understand the potential consequences of using short time horizons to judge the CO_2 impact of policies;
  - *Near-term CO_2 emissions targets are not important because they result in near-term benefits but rather because they result in reduced long-term cumulative emissions of CO_2 which, according to modeling, will determine peak global temperatures.*
  - *Policies that judge mitigation measures only on near-term emissions could discourage the use of some forest bioenergy mitigation measures that accomplish significant long-term reductions in cumulative CO_2 emissions.*
  - *The time horizon used to judge the warming impacts of biogenic CO_2 should be the same as used for other GHGs.*
- Policy makers should be aware of the robust literature indicating that, in response to increased demand for wood, forest owners and managers in the U.S. undertake activities that reduce the carbon impacts of increased harvesting;
- There are significant carbon benefits of using manufacturing residuals for energy
  - *The literature shows that using manufacturing residuals for energy results in net zero biogenic emissions impact over short time horizons when compared to alternative management scenarios*

NATIONAL COUNCIL FOR AIR AND STREAM IMPROVEMENT, INC.

1513 Walnut Street
Suite 200
Cary, NC 27511

(919) 941-6400
(919) 941-6401
ncasi.org

- There are a number of important factors to consider when using a periodically updated reference point baseline.
    - *The insensitivity of global temperatures to short-term (e.g., multi-decadal) changes in carbon stocks and CO_2 emissions;*
    - *An averaging period adequate to buffer out temporary market- and management-related impacts;*
    - *An updating interval long enough to reduce the possibility that an updated baseline is distorted by temporary market- and management-related impacts;*
    - *Statistical techniques to ensure that excursions below the baseline are not due to random variation; and*
    - *Provisions allowing examination of the causes for excursions below the baseline to avoid penalizing wood markets for losses of carbon that are due to other causes (most notably, urban expansion and natural disturbances).*

In the following material, we elaborate on these points.

<u>The potential consequences of using short time horizons to judge the CO_2 impact of policies.</u>

The SAB's August 2018 draft correctly notes that the selection of a time horizon for assessing net emissions of GHGs is primarily a policy decision. That said, there are science-based considerations associated with the selection of a time horizon that policy makers need to understand.

Due to the large amounts of CO_2 already in the atmosphere, near-term changes in CO_2 emissions have little impact on near-term CO_2 in the atmosphere. IPCC indicates that in 2013 the atmosphere contained 828 Petagrams (Pg) of carbon (IPCC 2013) and that, considering all sources and sinks, this was increasing at a rate of 4 Pg C per year, an annual increase of less than one-half of one percent. Over time, this rate of increase becomes very significant, but on a year-to-year basis or even decadal basis, near-term changes in CO_2 emissions cause only small changes in the amounts of CO_2 in the atmosphere. It makes sense, therefore (as discussed below) that climate models indicate that global temperatures are relatively insensitive to near-term emission trends. The urgency associated with reducing CO_2 emissions in the near-term, therefore, is not associated with impacts related to near-term levels of CO_2 in the atmosphere. Instead, there are other reasons why near-term CO_2 emissions are important.

CO_2 has a long residence time in the atmosphere. Consequently, near-term emissions contribute directly to long-term cumulative CO_2 emissions, which according to IPCC analysis, will determine eventual peak global temperature. There is a robust body of literature on the timing of global temperature impacts attributable to CO_2. In summarizing this literature, IPCC states the following:

> "taking into account the available information from multiple lines of evidence (observations, models and process understanding), the near linear relationship between cumulative CO_2 emissions and peak global mean temperature is well established in the literature and robust for cumulative total CO_2 emissions up to about 2000 PgC [petagrams of carbon]. It is consistent with the relationship inferred from past cumulative CO_2 emissions and observed warming, is supported by process understanding of the carbon cycle and global energy balance, and emerges as a robust result from the entire hierarchy of models (IPCC 2013, p. 102)"

More recently, U.S. Global Change Research Program concluded that;

> "Large reductions in emissions of the long-lived GHGs [like CO_2] are estimated to have modest temperature effects in the near term (e.g., over one to two decades) because total atmospheric concentration levels require long periods to adjust, but are necessary in the long term to achieve any objective of preventing warming of any desired magnitude. Near-term projections of global mean surface temperature are therefore not strongly influenced by changes in near-term emissions but rather dominated by natural variability, the Earth system response to past and current GHG emissions, and by model spread (i.e., the different climate outcomes associated with different models using the same emissions pathway)." (USGCRP 2017 Pg. 394)

Ultimately, the urgency associated with calls to reduce near-term emissions is a reflection of the enormity of the task of reducing cumulative emissions and the difficult political and economic adjustments that will be required to do so. IPCC speaks directly to this in its Fifth Assessment Report, explaining that,

> "the concept of cumulative carbon ... implies that higher initial emissions can be compensated by a faster decline in emissions later or by negative emissions. However, in the real world short-term and long-term goals are not independent and mitigation rates are limited by economic constraints and existing infrastructure (IPCC 2013, p. 1113)"

Policy makers need to understand, therefore, that near-term CO_2 emissions targets (e.g., the 2030 targets in the now-withdrawn Clean Power Plan) are important due to their contribution to reducing long-term cumulative emissions of CO_2 and not because they result in near-term benefits.

With this understanding, it becomes clear that mitigation measures to reduce CO_2 emissions should not be judged only on emissions reductions in the near-term. This is not normally an issue because, in most cases, mitigation measures reduce emissions in both the near- and long-terms. For instance, displacing fossil fuel-generated electricity with wind-generated electricity reduces both near-term and cumulative CO_2 emissions. Some forest bioenergy systems, however, can increase emissions in the near term even while they significantly reduce cumulative CO_2 emissions in the longer term relative to the use of competing systems. The timing of benefits varies among different measures and circumstances, but the principle remains and is supported by a rich body of literature. (See, for instance, Fargione et al. 2008, Gibbs et al. 2008, Jones et al. 2010, McKechnie et al. 2011, Mitchell et al. 2012, Zanchi et al. 2012, Agostini et al. 2013, Lamars and Junginger 2013, Lagiaiere et al. 2016, Brackley et al. 2017).

Therefore, it is important for policy makers to understand that policies that judge mitigation measures only on near-term emissions could discourage the use of some forest bioenergy mitigation measures that accomplish significant long-term carbon benefits.

In addition, policy makers need to understand that there is a policy-based time horizon embedded in many emissions targets. In specific, any policies that directly or indirectly make use of global warming potentials (GWPs) require the time horizon to be specified. Normally, 100-year GWPs are used, meaning that the warming impact of each gas (in terms of cumulative radiative forcing) is determined over 100 years and compared to CO_2. *It is scientifically inconsistent to use a short time horizon to characterize the net impacts of biogenic CO_2 when other GHGs are being judged over longer horizons.*

In response to increased demand for wood, forest owners and managers undertake activities that reduce the carbon impacts of increased harvesting.

We appreciate SAB's concern about the uncertainty introduced by the use of forest carbon models that consider both biophysical and economic factors. The SAB is on sound scientific ground when it recommends that any model used for determining net emissions of biogenic CO_2 in a regulatory context be thoroughly vetted to ensure it is appropriate for the task. That said, it is important that policy makers not be discouraged from considering the body of research based on the use of combined biophysical and economic models.

Studies that address both biophysical and economic factors show that when demand for wood increases, forest owners and managers in the U.S. undertake activities that increase supplies of wood and help mitigate the carbon-related impacts of increased harvesting. The size and timing of this investment response varies among studies, due in part to varying scenarios and uncertainties in the modeling, but the underlying message is clear. Studies that fail to account for the response of forest owners and managers overstate the carbon impacts of increased harvesting in the U.S. (See, for instance, Daigneault et al. 2012, Sedjo and Tian 2012, Nepal et al. 2014, Miner et al. 2014, Duden et al. 2017, Tian et al. 2018.)

The challenge for policy makers is to develop regulations that are robust in the face of modeling and scenario uncertainties while being informed by the large body of research showing that it is essential to consider economic factors and landowner responses when estimating the net biogenic carbon impacts associated with policies that increase demand for wood.

Using manufacturing residuals for energy results in net zero biogenic GHG emissions in short time periods.

Policy makers need to be aware of the literature examining the use of forest products industry manufacturing residuals for energy generation. This work indicates that using these residuals for energy results in net zero biogenic emissions impact over short time horizons when compared to alternative management scenarios involving (a) burning without energy recovery (black liquor solids, for instance) or (b) anaerobic decomposition involving methane production (landfilled woody mill residuals, treatment plant and deinking residuals, for instance). The biogenic carbon impacts of using these materials for energy are examined in Gaudreault et al. 2012, Lamars and Junginger 2013, and Gaudreault et al. 2015, among other studies.

Policy makers need to consider several important factors when designing and implementing a periodically updated reference point baseline.

The August 2018 draft SAB review correctly observes that while the anticipated baseline approach has conceptual advantages over the reference point baseline approach, these must be balanced against the uncertainties and implementation challenges associated with anticipated baselines. SAB appropriately highlights Buchholz et al. (2014) which concludes that "given the challenges in predicting the future status of forest resources, anticipated future baselines might be best suited for planning and policy development, while constant reference baselines might be more appropriate for monitoring and regulatory frameworks." The Buchholz et al. (2014) analysis also indicates that, based on the needs of specific monitoring frameworks, baselines of all types may need to be updated periodically. Given these considerations, the August 2018 SAB review suggests due consideration of an approach involving periodically updated reference point baselines. The SAB discussion of this approach is helpful but misses several important issues, discussed here.

Forest carbon stocks are always changing. At small spatial scales, these changes can be large. The atmosphere, however, responds to changes in CO_2 emissions over large spatial scales. Furthermore, forest management and investment responses occur over time and at large spatial scales. These and other considerations support SAB's recommendation that carbon impacts be judged at the regional scale or larger.

Temporal scales for assessing forest carbon stocks are also important, however. As noted above, short-term (e.g., mulit-decadal) increases in CO_2 emissions are relatively unimportant to global temperature except to the extent they contribute to long-term cumulative emissions. This provides important context for considering economic cycles and shifting age-class distributions that can cause temporary changes in carbon stocks. As long as these changes are temporary they are relatively unimportant to global temperature. This should be reflected in the design and implementation of policies based on periodically updated reference point baselines. Among the tools available to accomplish this are averaging periods, updating intervals and statistical tests.

The methods used to calculate, update and test against a reference point baseline will become increasingly important in the future as the rate of increase in forest carbon stocks in the U.S. slows (USDA 2016). Under these circumstances, cyclical factors will become increasingly likely to cause temporary reductions below baseline levels. A periodically updated reference point baseline approach needs to be designed to avoid unnecessary and administratively burdensome changes to emission factors over time. Careful selection of averaging periods, updating intervals and statistical tests can help avoid these unnecessary changes.

In the context of forest bioenergy policy, not only should forest carbon stocks be assessed at appropriate spatial and temporal scales, the causes of losses in forest carbon stocks should be understood. In many locations in the U.S., the primary threat to forest carbon stocks is urban expansion. In others, natural disturbances are causing large losses in forest carbon. Neither of these are attributable to forest bioenergy. Indeed, as noted above, forest bioenergy markets may help reduce these losses. Therefore, a forest bioenergy carbon accounting framework based on periodic measurement of forest carbon stocks should include provisions to identify the causes of carbon losses so that forest bioenergy is not held accountable for unrelated impacts.

Given these considerations, policy makers need to consider methods to make programs using periodically updated reference point baselines robust to (a) factors unrelated to the harvesting of wood and (b) temporary market- and management-related impacts. Among the factors to consider are the following:

- *The insensitivity of global temperatures to short-term (e.g., multi-decadal) changes in CO_2 emissions;*
- *The utility of an averaging period adequate to buffer out temporary market- and management-related impacts;*
- *The utility of an updating interval long enough to reduce the possibility that an updated baseline is distorted by temporary market- and management-related impacts;*
- *Statistical techniques that help ensure that excursions below the baseline are not due to random variation; and*
- *The value of examining the causes for excursions below the baseline to avoid penalizing wood markets for losses of carbon that are due to other causes (most notably, urban expansion and natural disturbances).*

We hope you find these comments helpful.

References

Agostini, A., J. Giuntoli, and A. Boulamanti (2013.) *Carbon accounting for forest bioenergy: Conclusions and recommendations from a critical literature review*. Joint Research Centre Institute for Energy and Transport, Scientific and Policy Rep. EUR 25354, European Commission, Luxembourg, Belgium. 85 p.

Brackley, A., D. Nicholls, M. Puettmann, E. Oneil (2017) *Life cycle assessment of wood energy for residential heating opportunities for wood pellet production in southeast Alaska*. Gen. Tech. Rep. PNW-GTR-951. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 34 p.

Buchholz, T., S. Prisely, G. Marland, C. Canham and N. Sampson ((2014) *Uncertainty in projecting GHG emissions from bioenergy*. Nature Climate Change. Vol 4. December 2014

Daigneault, A., B. Sohngen, and R. Sedjo. (2012) *Economic approach to assess the forest carbon implications of biomass energy*. Environ. Sci. Technol. 46:5664 –5671.

Duden, A., P. Verweij, M. Junginger, R. Abt, J. Henderson, V. Dale, K. Kline, D. Karssenberg, J. Verstegen, A. Faaij, F. van der Hilst, (2017) *Modeling the impacts of wood pellet demand on forest dynamics in southeastern United States*, Biofuel, Bioprod. Bioref. 11:1007–1029 (2017)

Intergovernmental Panel on Climate Change (IPCC). 2013. *Climate change 2013: The physical science basis.* Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, et al. (eds.). Cambridge University Press, Cambridge, UK and New York. 1535 p.

Fargione, J., J. Hill, D. Tilman, S. Polasky, and P. Hawthorne (2008) *Land clearing and the biofuel carbon debt*. Science 319:1235– 1238.

Gaudreault, C., B. Malmberg, B. Upton and R. Miner. *Life cycle greenhouse gases and non-renewable energy benefits of kraft black liquor recovery*. Biomass and Bioenergy Volume 46, November 2012, Pages 683–692, Elsevier

Gaudreault, C. and R. Miner. (2015) *Temporal aspects in evaluating the GHG mitigation benefits of using residues from forest products manufacturing facilities for energy production*. Journal of Industrial Ecology 19 (6). 994-1077. 2015

Gibbs, H., M. Johnston, J. Foley, T. Holloway, C. Monfreda, N. Ramankutty, and D. Zaks (2008) *Carbon payback times for crop-based biofuel expansion in the tropics: The effects of changing yield and technology*. Environ. Res. Lett. 3 (2008):034001. 10 p..

Jones, G., D. Loeffler, D. Calkin, and W. Chung (2010) *Forest treatment residues for thermal energy compared with disposal by onsite burning: Emissions and energy return*. Biomass Bioenergy 34:737–746.

Lamars, P., and M. Junginger (2013) *The 'debt' is in the detail: A synthesis of recent temporal forest carbon analyses on woody biomass for energy*. Biofuels Bioproducts Biorefining 7:373–385.

Mckechnie, J., S. Colombo, J. Chen, W. Mabee, and H. Maclean (2011) *Forest bioenergy or forest carbon? Assessing the trade-offs in greenhouse gas mitigation with wood-based fuels*. Environ. Sci. Technol. 2011:789 –795

Miner, R., R. Abt, J. Bowyer, M. Buford, R. Malmsheimer, J. O'Laughlin, E. Oneil, R.Sedjo, K. Skog. *Forest Carbon Accounting Considerations in U.S. Bioenergy Policy*. Journal of Forestry 112 (6): 591-606. November 2014

Mitchell, S., M. Harmon, and K. O'Connell (2012) *Carbon debt and carbon sequestration parity in forest bioenergy production*. Glob. Change Biol. Bioenergy 4:818–827.

Nepal, P., D. Wear, and K. Skog (2014) Net change in carbon emissions with increased wood energy use in the United States. Glob. Change Biol. Bioenergy. doi: 10.1111/gcbb.12193.

Sedjo, R., and X. Tian (2012) *Does wood bioenergy increase carbon stocks in forests?*, J. For. 110:304 –311.

Tian, X, B. Sohngen, J. Baker, S. Ohrel, A. Fawcett, (2018) *Will U.S. Forests Continue to Be a Carbon Sink?, Land Economics,* February 2018, 94 (1): 97–113

USDA (2016) *Future of America's Forests and Rangelands Update to the Forest Service 2010 Resources Planning Act Assessment*. Gen. Tech. Rep. WO-94, September 2016

USGCRP, 2017: *Climate Science Special Report: Fourth National Climate Assessment, Volume I* U.S. Global Change Research Program, Washington, DC, USA, 470 pp., doi: 10.7930/J0J964J6.

Zanchi, G., N. Pena, and N. Bird (2012) *Is woody bioenergy carbon neutral? A comparative assessment of emissions from consumption of woody bioenergy and fossil fuel*. Glob. Change Biol. Bioenergy 4:761–772.

NATURAL RESOURCES DEFENSE COUNCIL and CLEAN AIR TASK FORCE

Comments On

DRAFT SCIENCE ADVISORY BOARD REVIEW OF ENVIRONMENTAL PROTECTION AGENCY'S FRAMEWORK FOR ASSESSING BIOGENIC CO_2 EMISSIONS FROM STATIONARY SOURCES

September 2018

SUMMARY OF RECOMMENDATIONS

The following is a Summary of Recommendations submitted jointly by the Clean Air Task Force and the Natural Resources Defense Council. Attached to this Summary are our full-length comments, offering additional discussion and citations in support of our recommendations. Our organizations appreciate the opportunity to comment on this important process and look forward to working further with the SAB and the EPA to ensure that biogenic CO2 emissions from stationary sources are properly counted.

RECOMMENDATION 1: AMEND PARAGRAPHS ON REFERENCE POINT ACCOUNTING

This Board, in its 2012 final report to the EPA on biogenic carbon accounting,[1] accurately summarized the purpose of a biogenic CO2 accounting framework:

> "[T]he Framework should provide a means to estimate the effect of stationary source biogenic feedstock demand, on the atmosphere, over time, comparing a scenario with the use of biogenic feedstocks to a counterfactual scenario without the use of biogenic feedstocks....estimating additionality, i.e. the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand."

It also reviewed the reference point baseline approach against this additionality criterion and concluded:

> "EPA's reference point baseline approach (comparing the net change in carbon stocks between two points in time) does not provide an estimate of the additional emissions and the sequestration changes in response to biomass feedstock demand. ...and implies that forest biomass emissions could be granted an exemption simply because the location of a stationary facility is in an area where forest stocks are increasing."

Finally, the Board's 2012 final report recommended accounting that does not credit or penalize bioenergy users for changes that would otherwise occur:

[1] SAB Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources (September 2011) at page 5 (September 28, 2012) (https://yosemite.epa.gov/sab/sabproduct.nsf/0/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf).

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> "An anticipated baseline requires selecting a time period and determining what would have happened anyway without the harvesting and comparing that impact with the carbon trajectory associated with harvesting of biomass for bioenergy."

Concern: We are concerned that the passage below from the 2018 draft's Executive Summary breaks from these findings in favor of adjustments to the reference point baseline:

> "In 2012, the SAB recommended a future anticipated baseline approach to capture the additional CO2 emissions to, or uptake from, the atmosphere created by any increased use of biomass for energy. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis along with a reference point approach in its 2014 Framework. The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks." (page 2, lines 8-14).

Recommended Change: We recommend the following changes (and recommend applying comparable changes to a similar paragraph on page 7 of the report):

> In 2012, the SAB recommended a future anticipated baseline approach to capture the additional CO2 emissions to, or uptake from, the atmosphere created by any increased use of biomass for energy. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis along with a reference point approach in its 2014 Framework. ~~The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.~~ **Whatever baseline is used, it must be coupled with a modeling structure that evaluates only the incremental effects of the bioenergy use and does not credit or penalize bioenergy users for changes that would otherwise occur.**

RECOMMENDATION 2: DELETE PARAGRAPHS CONCERNING "LANDSCAPE APPROACHES"

In Section 3.4, the 2018 draft report's recommendation *requires* a "landscape approach" to account for the impacts of biomass demand on carbon stocks, stating "[s]tationary facilities require a continuous supply of feedstock, thus a landscape approach is required for accounting for the impacts of feedstock demand on carbon stocks." (page 9, lines 22-23). The draft report supports this recommendation in two passages, which use similar and sometimes duplicative language:

> At pp. 8-9: Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach. A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and credits that determine carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks. As noted by Cintas et al. (2016), "assessment at the landscape scale integrates the effects of all changes in the forest

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management and harvesting regime that take place in response to – experienced or anticipated – bioenergy demand. Taken together, these changes may have a positive, negative or neutral influence on the development of forest carbon balances."

At p. 11: Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed in a regulated manner (i.e., completely asynchronously), and the order in which losses and gains occur becomes meaningless at the landscape level because both simultaneously occur; thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the reference scenario, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.

Concern: These paragraphs rely on undefined terms and do not distinguish among key measures of carbon stock changes.[2] As a result, the SAB's basis for its recommendation is ambiguous, difficult to understand, and open to multiple interpretations. The SAB should not support, let alone *require*, an analytic approach that suffers from such flaws, as is the case for the "landscape approach." Moreover, the SAB should not rely on economic models without a careful review of their validity.

Recommended Change: We recommend that the SAB delete these two paragraphs, as well as the accompanying recommendation at the end of Section 3.4 (on p. 9).

[2] For example, the paragraphs do not distinguish between *carbon stored* for an individual scenario and the *net change in stored carbon* based on the difference between two scenarios, two fundamentally different quantities. As a result, the paragraphs could be interpreted in vastly different ways – one of which would contradict the SAB's earlier finding that "merely knowing whether carbon sequestration at the landscape level has increased or decreased tells us nothing about the incremental effect that bioenergy production has on carbon emissions." (SAB, 2012)

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NATURAL RESOURCES DEFENSE COUNCIL | CLEAN AIR TASK FORCE

Thomas Carpenter
Designated Federal Officer
Science Advisory Board—Biogenic Carbon Emissions Panel
US Environmental Protection Agency
Via email

Re: Draft Science Advisory Board Review of Environmental Protection Agency's Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

Dear Dr. Carpenter and Members of the EPA Science Advisory Board:

Natural Resources Defense Council and Clean Air Task Force appreciate the opportunity to provide the following comments on the Environmental Protection Agency Science Advisory Board (SAB) Draft Review of EPA's 2014 Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources.

The central task of the Science Advisory Board's (SAB) review is written into the title of the report it is charged with reviewing: *A Framework for Assessing Biogenic CO2 Emissions from* ***Stationary Sources.*** This title grounds this effort in a practical need—namely, evaluating the greenhouse gas (GHG) emissions of regulated power stations burning biomass. The outcome of any biogenic CO2 accounting system must enable EPA to determine whether, and to what extent, to credit a regulated, biomass-burning facility with offsetting carbon re-sequestration based on new plant growth that would not have otherwise occurred. Specifically, it must allow EPA to determine and regulate, not retroactively, but in real time, the impacts of an individual stationary source; prevent free-ridership and avoid crediting or penalizing stationary sources for the actions of independent actors over which they have no control; and ensure alignment with climate policy goals by comparing what happens to forest carbon stocks under a policy scenario, in which biomass is harvested and converted into energy in response to new policy-driven demand, to a baseline scenario, which assumes business as usual .

For its part, the SAB's report must be written in a way that advances EPA's understanding of the key scientific underpinnings of such an accounting system.

Since 2012, the Chartered SAB (henceforth: SAB) and its Panel on Biogenic Carbon Emissions (henceforth: the Panel) have repeatedly recognized the importance of the importance of these threshold requirements, and in particular emphasized that any system for evaluating the net emissions of a biomass-burning stationary source must compare the biogenic CO2 emissions that occur under the biomass use scenario against the emissions that would occur in a well-characterized baseline. We are concerned that the 2018 draft report's discussion of the merits of two different types of baselines—the anticipated baseline approach and the reference point approach—is incomplete, and we fear that it could be read in a way that is inconsistent with numerous statements provided elsewhere in the 2018 draft report, and in previous statements co-signed by the chair of the SAB.

Below, we address three key sections of the 2018 draft report. Wherever possible, we lay out specific passages that appear contradictory or subject to multiple interpretations, and recommend specific fixes, indicated in bold and via strikethrough.

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1. Language from the 2018 draft report breaks from previous statements by the SAB that caution EPA against the use of a reference point approach[3] and urge the Agency to develop "an anticipated baseline approach that allows assessment of *additional* emissions."[4]

The process of reviewing EPA's 2011 and 2014 Accounting Frameworks generated a range of disagreements around complex issues, including, most notably, the disagreement between the SAB and the Panel over the appropriate time horizon for calculating a BAF. Clearly, the SAB is not bound by previous analyses presented in Panel-authored reports. At the same time, there has been widespread support among members of the SAB and the Panel for including a counterfactual baseline scenario, just as there has been widespread concern about the use of a historic reference point scenario. The SAB should be reluctant to set aside these consensus positions.

In a cover letter to the SAB's 2012 Report (considered final by EPA and henceforth referred to as the 2012 Final Report) reviewing EPA's 2011 Framework, SAB Dr. Chair Deborah L. Swackhamer and Panel Chair Dr. Madhu Khanna wrote jointly:

> In general the Framework should provide a means to estimate the effect of stationary source biogenic feedstock demand, on the atmosphere, over time, comparing a scenario with the use of biogenic feedstocks to a counterfactual scenario without the use of biogenic feedstocks. In the attached report, the SAB provides some suggestions for an "anticipated baseline" approach while acknowledging the uncertainty and difficulty associated with modeling future scenarios.[5]

The letter from Drs. Swackhamer and Khanna also emphasized the importance of "additionality"

> Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach.[6]

The argument for including an anticipated baseline approach as an option for determining a BAF is described at length in the SAB's 2012 Final Report:

> To accurately capture the carbon outcome, an anticipated baseline approach and landscape level perspective are needed. An anticipated baseline requires selecting a time period and determining what would have happened anyway without the harvesting and comparing that impact with the carbon trajectory associated with harvesting of biomass for bioenergy. Although

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[3] SAB Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources (September 2011)—Cover Letter to EPA from Drs. Deborah L. Swackhamer, Chair of Science Advisory Board and Madhu Khanna, Chair of SAB Biogenic Carbon Emissions Panel to EPA, at ii (September 28, 2012) ("SAB Cover Letter September 2012") (https://yosemite.epa.gov/sab/sabproduct.nsf/0/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf).

[4] SAB Draft Report (8/27/15)—Cover Letter to EPA from Drs. Peter S. Thorne, Chair of Science Advisory Board and Madhu Khanna, Chair of SAB Biogenic Carbon Emissions Panel to EPA, at ii (emphasis in original) (August 27, 2015) ("SAB Cover Letter August 2015") (https://yosemite.epa.gov/sab/sabproduct.nsf/0/BE340711E6D9B47385257EAE006ED147/$File/8-27-15+Draft+Advisory_changes+accepted.pdf).

[5] SAB Cover Letter September 2012 at ii.

[6] *Id*.

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> any "business as usual" projection would be uncertain, it is the only means by which to gauge the incremental impact of woody biomass harvesting.[7]

The Final Report and the subsequent draft Panel reports from 2015-2017 point out that the 2011 Framework did not distinguish the incremental effects of bioenergy from effects that would have otherwise occurred. EPA's 2011 Framework could have improperly credited or penalized bioenergy operations with gains or losses in terrestrial carbon stocks that would occur anyway. It also failed a basic test of logic in that the same bioenergy plant, burning the same biomass, could appear to have dramatically different CO2 emissions depending on where it was located. The 2012 Final Report rejected this approach on the basis that it could not assess the "additionality" of any carbon benefit claims and would allow for free-ridership:

> The choice of a fixed reference point may be the simplest to execute, but it does not properly address the additionality question, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of bioenergy. The agency's use of a fixed reference point baseline coupled with a division of the country into regions implies that forest biomass emissions could be granted an exemption simply because the location of a stationary facility is in an area where forest stocks are increasing. The reference point estimate of regionwide net emissions or net sequestration does not indicate, or estimate, the difference in greenhouse gas emissions (the actual carbon gains and losses) over time that stem from biomass use. As a result, the Framework fails to capture the causal connection between forest biomass growth and harvesting and atmospheric impacts and thus may incorrectly assess net CO2 emissions of a facility's use of a biogenic feedstock.[8]

We are concerned that a passage in the Executive Summary breaks from these previous analyses:

> In 2012, the SAB recommended a future anticipated baseline approach to capture the additional CO2 emissions to, or uptake from, the atmosphere created by any increased use of biomass for energy. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis along with a reference point approach in its 2014 Framework. The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.

A similar passage on page 7, lines 2 – 21 reads:

> In the 2012 SAB report, we noted temporal problems with the reference point baseline approach. The EPA has acknowledged this in its 2014 Framework and included a future anticipated baseline analysis alternative along with a reference point approach. The limitations of a reference point approach can be reduced by deploying a shifting reference point (updated at regular intervals using empirical data (e.g. every 5 or 10 years)), which is designed to capture increased regional carbon stocks.

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[7] SAB Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources (September 2011) at 5 (September 28, 2012) (https://yosemite.epa.gov/sab/sabproduct.nsf/0/57B7A4F1987D7F7385257A87007977F6/$File/EPA-SAB-12-011-unsigned.pdf).

[8] *Id*. at 5-6. Each of the draft SAB reviews released in 2015, 2016, and 2017 includes a similar discussion of the merits of the anticipated baseline approach and the shortcomings of reference point approach.

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> The SAB's 2012 advice on the anticipated baseline approach explored the use of complex modeling in order to try to capture interactions among the market, land use, investment decisions, and emissions and ecosystem feedbacks, and to construct a counter-factual scenario that does not include increased bioenergy use. In the case of long rotation feedstocks, bioenergy demand can affect carbon stocks in many ways including the ages at which trees are harvested, the diversion of forest biomass from traditional forest product markets to bioenergy, and the rates of afforestation and deforestation. The complexity of such a modeling approach makes it difficult to parameterize and validate. The lack of empirical data regarding many of these relationships and the resulting uncertainties pose a significant challenge to use of this type of model in a regulatory context. Estimating the net effect of these changes on carbon stocks requires a model that integrates market demand and supply conditions with biophysical conditions that determine growth of forest biomass, losses via decomposition, carbon sequestration and fluxes due to harvests and land use change and incorporates the spatial variability in these effects across the U.S. Employing models of this complexity is likely beyond the capabilities of many practitioners.[9]

All approaches to biogenic CO2 accounting have strengths and weaknesses, and ultimately must be compared against the relative strengths and weaknesses of a viable alternative. While the debate over the Panel's support for an extended time horizon for calculating the BAF dominated the SAB's August 2017 public meeting and ultimately led the SAB to reject the Panel's 2014 report, there has been no comparable public debate over whether the SAB should revisit its recommendations that EPA ought to consider the use of an anticipated baseline approach or that it ought to be wary of relying on reference point scenarios. The 2012 Final Report, the draft Panel reports, and the transmittal letters signed by the SAB Chair consistently supported the use of anticipated baselines and expressed concerns about reference point scenarios.

The various reports and letters openly acknowledged the "uncertainty and difficulty" associated with counterfactual modeling and pointed out that, "practical considerations must weigh heavily in the agency's decision making."[10] They note, as the current 2018 SAB draft report does, that estimating the net effect on carbon stocks from changes in average harvest age, the diversion of forest biomass from traditional markets to energy markets, and the rates of afforestation and deforestation requires a model that integrates market demand and supply conditions with a variety of biophysical conditions.[11]

However, these earlier reports and discussions do not support the assertion that, "Employing models of this complexity is likely beyond the capabilities of many practitioners."[12] Several biophysical models have been developed and documented in the peer reviewed literature.[13] As indicated above, we

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[9] SAB Draft Report (8-29-18)—Cover Letter to EPA from Chartered SAB, at 7, lines 2 - 21 (August 29, 2018) ("SAB Draft Report August 2018") (https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/521CDCBF9B028BCE852582F80065B320/$File/Biogenic_Carbon_+Qual_Rev-8-29-18.pdf).

[10] SAB 2016 Draft Report at 11.

[11] *Id*. at 10.

[12] SAB Draft Report August 2018 at 7.

[13] Mitchell, S. R., Harmon, M. E. & O'Connell, K. E. B. Carbon debt and carbon sequestration parity in forest bioenergy production. GCB Bioenergy 4, 818–827 (2012).
Holtsmark, B. Harvesting in boreal forests and the biofuel carbon debt. Clim. Change 112, 415–428 (2012).
Hudiburg, T. W., Law, B. E., Wirth, C. & Luyssaert, S. Regional carbon dioxide implications of forest bioenergy production. Nat. Clim. Change 1, 419–423 (2011).

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therefore recommend that the SAB remove the sentence in the 2018 draft report (at page 7, line 21) that suggests that these types of models are too complex to be used.

Similarly, there is no indication from the earlier reports and discussions that, "The limitations of the reference point approach can be reduced by deploying a shifting reference point (updated at regular intervals using empirical data (e.g. every 5 or 10 years)), which is designed to capture increase regional carbon stocks."

We recommend that the SAB to remove that text (at page 7, line 2 – 7), and revise the passage to read as follows:

> In the 2012 SAB report, we noted temporal problems with the reference point baseline approach. The EPA has acknowledged this in its 2014 Framework and included a future anticipated baseline analysis alternative along with a reference point approach. ~~The limitations of a reference point approach can be reduced by deploying a shifting reference point (updated at regular intervals using empirical data (e.g. every 5 or 10 years)), which is designed to capture increased regional carbon stocks.~~ **Whatever baseline is used, it must be coupled with a modeling structure that evaluates only the incremental effects of the bioenergy use and does not credit or penalize bioenergy users for changes that would otherwise occur.**
>
> The SAB's 2012 ~~advice on~~ **Report recommended** the anticipated baseline approach **and** explored the use of complex modeling in order to try to capture interactions among the market, land use, investment decisions, and emissions and ecosystem feedbacks, and to construct a counter-factual scenario that does not include increased bioenergy use. In the case of long rotation feedstocks, bioenergy demand can affect carbon stocks in many ways including the ages at which trees are harvested, the diversion of forest biomass from traditional forest product markets to bioenergy, and the rates of afforestation and deforestation. The complexity of such a modeling approach makes it difficult to parameterize and validate. The lack of empirical data regarding many of these relationships and the resulting uncertainties pose a significant challenge to **the** use of this type of model in a regulatory context. ~~Estimating the net effect of these changes on carbon stocks requires a model that integrates market demand and supply conditions with biophysical conditions that determine growth of forest biomass, losses via decomposition, carbon sequestration and fluxes due to harvests and land use change and incorporates the spatial variability in these effects across the U.S. Employing models of this complexity is likely beyond the capabilities of many practitioners.~~

We likewise urge SAB to revise the text in the Executive Summary at page 2, lines 8 – 14, as follows:

> In 2012, the SAB recommended a future anticipated baseline approach to capture the additional CO2 emissions to, or uptake from, the atmosphere created by any increased use of biomass for energy. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis along with a reference point approach in its 2014 Framework. ~~The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account~~

McKechnie, J., Colombo, S., Chen, J., Mabee, W. & MacLean, H. L. Forest bioenergy or forest carbon? Assessing trade-offs in greenhouse gas mitigation with wood-based fuels. Environ. Sci. Technol. 45, 789–795 (2011).
Holtsmark, B. The outcome is in the assumptions: analyzing the effects on atmospheric CO2 levels of increased use of bioenergy from forest biomass. GCB Bioenergy 5, 467–473 (2013).

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~~for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.~~ **Whatever baseline is used, it must be coupled with a modeling structure that evaluates only the incremental effects of the bioenergy use and does not credit or penalize bioenergy users for changes that would otherwise occur.**

2. The 2018 draft report's recommendation requiring use of a "landscape approach" is confusing and subject to multiple interpretations.

In Section 3.4, the 2018 draft report's recommendation *requires* a "landscape approach" to account for the impacts of biomass demand on carbon stocks, stating "[s]tationary facilities require a continuous supply of feedstock, thus a landscape approach is required for accounting for the impacts of feedstock demand on carbon stocks." (Page 9, lines 22-23). The draft report supports this recommendation in two passages, which use similar and sometime duplicative language:

> At pp. 8-9: Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach. A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and credits that determine carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks. As noted by Cintas et al. (2016), "assessment at the landscape scale integrates the effects of all changes in the forest management and harvesting regime that take place in response to – experienced or anticipated – bioenergy demand. Taken together, these changes may have a positive, negative or neutral influence on the development of forest carbon balances."
>
> At p. 11: Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed in a regulated manner (i.e., completely asynchronously), and the order in which losses and gains occur becomes meaningless at the landscape level because both simultaneously occur; thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the reference scenario, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.

These paragraphs rely on undefined terms and do not distinguish among key measures of carbon stock changes.[14] As a result, the SAB's basis for its recommendation is ambiguous, difficult to understand, and open to multiple interpretations. We therefore recommend that both paragraphs be deleted.

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[14] For example, the paragraphs do not distinguish between *carbon stored* for an individual scenario and the *net change in stored carbon* based on the difference between two scenarios, two fundamentally different quantities. As a result, the paragraphs could be interpreted in vastly different ways – one of which would contradict the SAB's earlier finding that "merely knowing whether carbon sequestration at the landscape level has increased or decreased tells us nothing about the incremental effect that bioenergy production has on carbon emissions." (SAB, 2012)

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3. The 2018 draft report relies on economic models in its recommended "landscape approach."

The SAB should not endorse economic models without a careful review of their validity. Many of the existing economic models share the same shortcomings as FASOM, and the 2018 draft report properly notes that, "[s]uch models have not been validated for this application, and heavy reliance on them is unwarranted." (SAB, 2018, page 2). Moreover, many of these models draw selective and/or arbitrary boundaries that do not properly count benefits and costs.

We do not object to modeling individual scenarios at a *landscape scale* (which we note is vastly different from the "landscape approach" proposed in the current draft report) using biophysical models that have been demonstrated for this application. Many biophysical models are suited for this purpose and have been documented in the peer reviewed literature.[15] These biophysical models rely on stand-level analysis that is aggregated in space to the landscape scale and integrated over time. One such study underscores the need for models "to consider the full range of landscape effects. The landscape includes a spatial component that requires aggregating across all stands that might be affected by bioenergy expansion. In addition, since a new bioenergy facility is likely to operate for many years, there is a temporal dimension that includes the effects of aggregating harvests over time."[16]

The SAB should not support, let alone *require*, an analytic approach based on concepts that are not defined, poorly understood, unvalidated, and subject to multiple interpretations, as is the case for the "landscape approach." We recommend therefore that the SAB delete these two paragraphs, as well as the accompanying recommendation at the end of Section 3.4 (on p. 9).

We appreciate the opportunity to comment on this important process and look forward to working with the SAB and the EPA to ensure that biogenic CO2 emissions from stationary source are properly accounted for.

Respectfully submitted,

Sami Yassa
Senior Scientist, Climate & Clean Energy Program
Natural Resources Defense Council
40 West 20th Street, NY NY 10011
www.nrdc.org

Jonathan F. Lewis
Senior Counsel
Clean Air Task Force
114 State Street, 6th Floor
Boston, MA 02109
www.catf.us

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[15] Mitchell, S. R., Harmon, M. E. & O'Connell, K. E. B. Carbon debt and carbon sequestration parity in forest bioenergy production. GCB Bioenergy 4, 818–827 (2012).
Holtsmark, B. Harvesting in boreal forests and the biofuel carbon debt. Clim. Change 112, 415–428 (2012).
Hudiburg, T. W., Law, B. E., Wirth, C. & Luyssaert, S. Regional carbon dioxide implications of forest bioenergy production. Nat. Clim. Change 1, 419–423 (2011).
McKechnie, J., Colombo, S., Chen, J., Mabee, W. & MacLean, H. L. Forest bioenergy or forest carbon? Assessing trade-offs in greenhouse gas mitigation with wood-based fuels. Environ. Sci. Technol. 45, 789–795 (2011).
Holtsmark, B. The outcome is in the assumptions: analyzing the effects on atmospheric CO2 levels of increased use of bioenergy from forest biomass. GCB Bioenergy 5, 467–473 (2013).

[16] Thomas Walker, Peter Cardellichio , John S. Gunn , David S. Saah & John M. Hagan (2013): Carbon Accounting for Woody Biomass from Massachusetts (USA) Managed Forests: A Framework for Determining the Temporal Impacts of Wood Biomass Energy on Atmospheric Greenhouse Gas Levels, Journal of Sustainable Forestry, 32:1-2, 130-158

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Mr. Thomas Carpenter
Designated Federal Officer
EPA Science Advisory Board Staff Office (1400R)
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, DC 20460

Dear Mr. Carpenter:
I am writing as a past researcher of carbon cycle science, carbon accounting, and carbon flux from terrestrial ecosystems. I also served as a member of the EPA Panel on Biogenic Carbon Emissions that provided input on the first two draft Frameworks.

I believe that the *draft SAB review* of the EPA's Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources summarizes the panel discussions and outcomes well, given the different scientific perspectives on a few of the issues. I generally support the logical conclusions of the *draft SAB review* on all five recommendations made on page 4 of the review document.

I would like to reiterate support, with additional explanation, for one of these findings. Key Finding number 2 is significant. The first framework tried to sum all the emissions (i.e., sum fluxes). This was not efficient and was prone to inaccuracies. The second framework switched to a stock-change approach, guided by methods of carbon accounting that have been implemented nationally and internationally. This type of approach coincides with approaches in the United States like the Forest Inventory Analysis. It is more straight forward and less prone to error. More importantly, it captures the overall changes in standing stock over a given region and a given time period. This finding is significant, because the change in standing stock due, for example, to a doubling in harvest over the US, may or may not be carbon neutral over a given time, depending on regrowth rates, land-use change, and rotation intervals. For example, if we double the national harvest, and if the harvest rates remain at that new level, the stock may theoretically decrease and remain lower until the harvest rates change again. Therefore, over the biophysical lifetime of the tree or forest stand, a tree or forest stand is carbon neutral in the long-term. However, over a landscape scale (e.g., sub-national or national), the impact of new forest policies may not be carbon neutral, even over the long-term. The stock-change approach would capture that reality, just as it does in the U.S. Forest Inventory Analysis program.

In conclusion, I think that the review of the SAB is sound and that regional BAFs for a number of biomass energy sources could be estimated in a relatively straight-forward manner by experienced researchers in core relevant disciplines, and done so by <u>not</u> including the complexities and highly uncertain factors that are interesting for complex research analyses but not necessarily fitting for regulatory frameworks.

Sincerely,

Tristram O. West, Ph.D.